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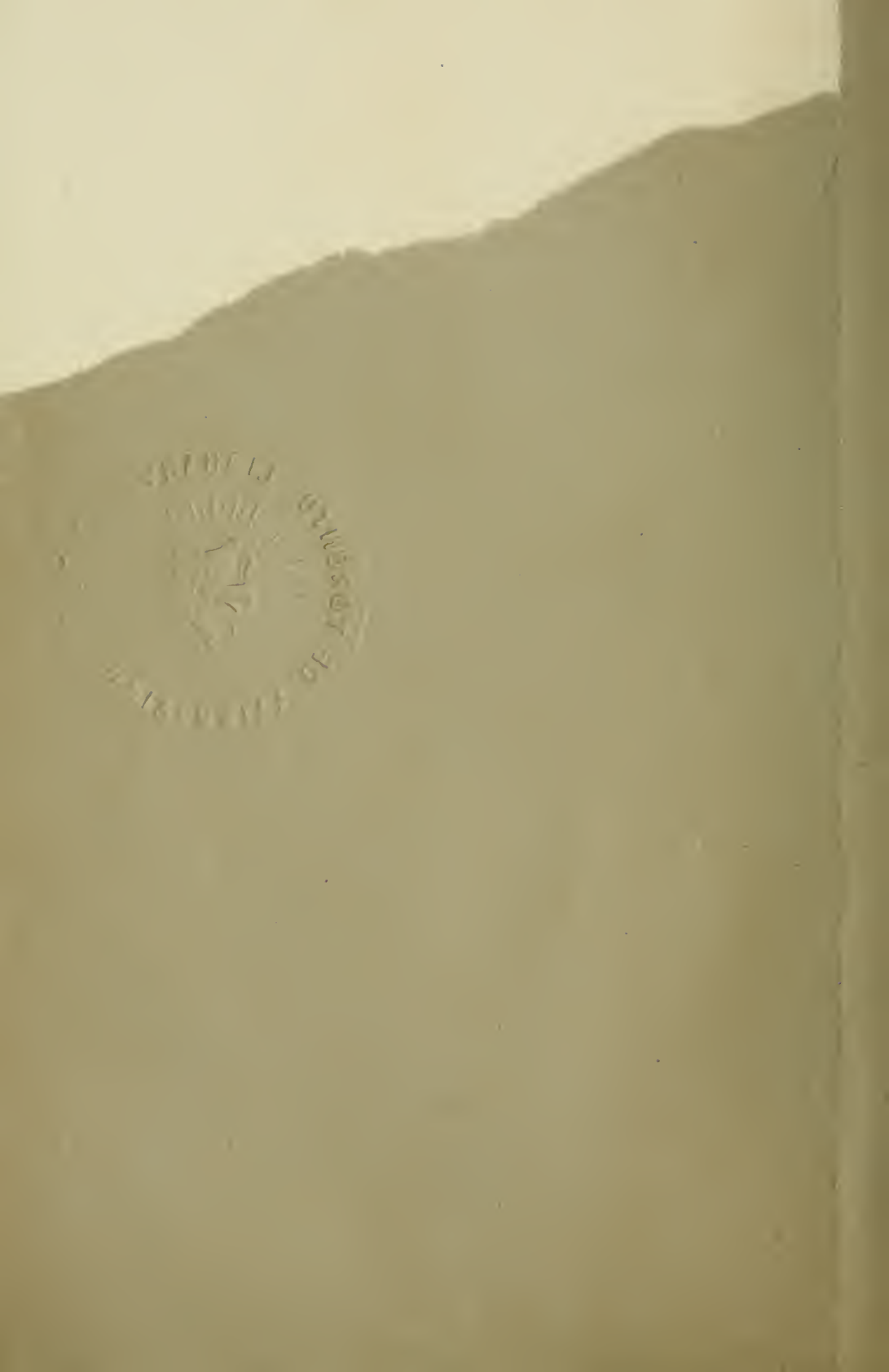

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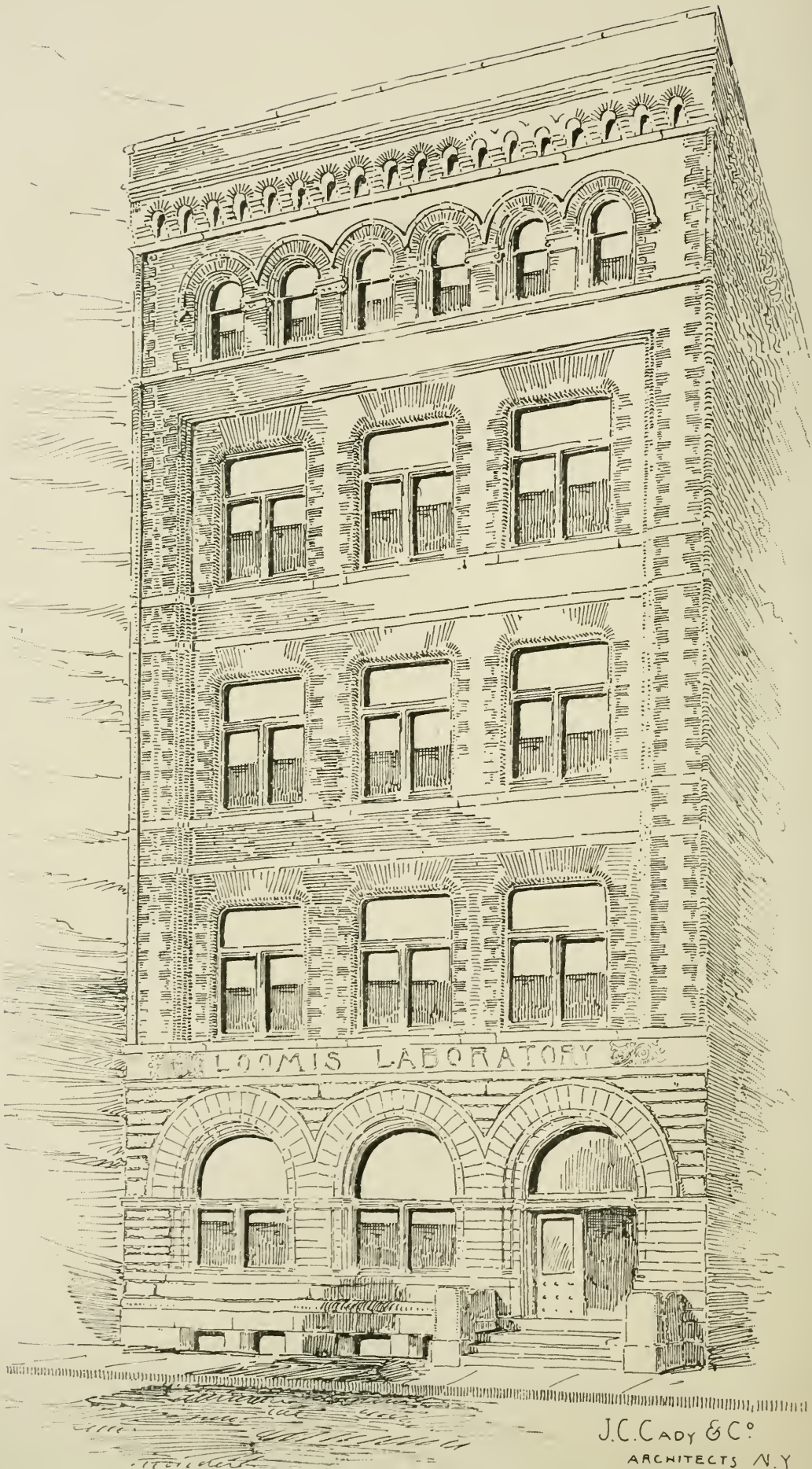
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NOTE.

The published "Researches of the Loomis Laboratory" are issued with the objects, first, of stimulating original investigation in the Laboratory by offering a desirable field for publication, and, secondly, with the view of keeping together the collected records of Laboratory work.

It is not expected that the "Researches" will be issued at any stated time, but they are to appear occasionally, whenever sufficient experimental work has accumulated.

THE LOOMIS LABORATORY.

Among the munificent gifts to educational institutions which have distinguished this country in recent years, the new Loomis Laboratory is in the foremost rank. Early in the year 1886, the Faculty of the Medical Department of the University of the City of New York made public the announcement that a gift of one hundred thousand dollars had been received for the erection and furnishing of a new Laboratory building, to be used for practical and scientific work in connection with the existing University Medical College buildings. The conditions of the gift were but two: First, that the building should be known as the "Loomis Laboratory of the Medical Department of the University of the City of New York," and, second, that the name of the donor should not be made public.

The donor has generously furnished sufficient funds to meet all deficiencies in the expenses of maintenance of the Loomis Laboratory since its organization, and he proposes to continue to support it, until he shall endow it

When the gift was received, a plot of ground, immediately adjoining the College building to the east, was at once purchased, and the erection of the Laboratory was completed before the close of the following year. On February 27th, 1888, the Loomis Laboratory was formally opened by a public reception, although it had been occupied by classes for some time previously. The building has a frontage on East 26th Street of thirty-five feet, and a depth of ninety feet. It is five stories in height, fire-proof throughout, thoroughly ventilated, and provided with elevators, steam heat, high and low water pressure, gas and electric lights. The floors are of asphalt, which permits of their being flooded for cleaning. The woodwork of the windows, doors, cases and tables is substantial and appropriate.

Upon the first, or entrance floor, is a large front room devoted to section-teaching in the Department of Materia Medica, Experimental Medicine and Electro-Therapeutics. The wall cases contain a museum of Materia Medica.

In the rear are two large rooms filled with the collections of the Department of Physics and Chemistry. The Laboratory of Physics contains valuable and very complete cabinets of apparatus accumulated by the Medical Department during the past ten years. In these cabinets are an induction coil by Ritchie, capable of giving an eighteen-inch spark; a large diamagnetic machine; a ten-foot direct-vision spectroscope made by Hilger of London, under the direction of the Astronomer Royal; saccharimeters of Laurent, Scheibler and Mitscherlich; a complete set of apparatus for electrical measurements; complete apparatus for the study of polarized light, etc.

Large additions to this collection have been quite recently made by the Professor of Physics and Chemistry and his Assistants. The work has been done for the most part in the work-room adjoining the larger Laboratory of Physics, which is fitted with a lathe for turning metals, and with all necessary tools.

The Laboratory of Physics communicates through wide sliding doors with the lower lecture hall, so that when the doors are parted, a portion of the laboratory is thrown into the lecture hall, displaying the apparatus which has been arranged for demonstration upon tables fitted with gas and water faucets, etc. Further back in the laboratory is a large oxy-hydrogen projection-apparatus mounted upon a movable table, to facilitate focussing objects upon curtains arranged to fall between the sliding doors.

The second floor is devoted to the Laboratory of Chemistry, and is divided into a general laboratory, a laboratory of special research, balance-room, furnace-room, and laboratory of toxicology. The general laboratory contains accommodations for sixty students working together. There are fifteen large tables, each having ample room for four stu-

dents, and each table is fitted with two separate sinks, with racks for reagent bottles, drawers, cupboards, gas and special ventilating apparatus. In this room are held the classes in urine analysis, toxicology, etc.

Each student is supplied with all apparatus and chemicals required, except urinometers, which are carefully corrected for the student that they may serve for future use.

The third floor is occupied by the students' Histological Laboratory and by the Physiological Laboratory.

The Histological Laboratory is in the rear. It is abundantly lighted by windows on the south and east, and is fitted with tables accommodating thirty-six students. Each student is provided with a Schrauer's microscope stand and Hartnack and Zeiss objective, together with all necessary reagents and accessories for class courses, and a locked cupboard in which to keep his materials. One end of this room is covered with blackboards.

The Physiological Laboratory occupies the front of the third floor. It consists of a large main laboratory with a smaller one adjoining it, which in turn communicates with a large room in the college building, from which there is easy access to the upper lecture hall, into which movable tables are taken with vivisections and apparatus for class-room demonstration. The Physiological Laboratory is abundantly supplied with apparatus and appliances for original research, as well as models, charts and instruments for use in the lecture hall. Much of the apparatus, and a large collection of automatic models intended to illustrate upon a large scale the mechanism of various physiological processes, have been made in the laboratory by the Professor of Physiology and his Assistants. During the past year the Alumni of the College have raised a fund to procure some of the elaborate recording instruments now used by Physiologists. During the past summer this collection of instruments has been manufactured for the laboratory and imported from Europe, and the laboratory is now well

supplied with kymographs, myographs (including a pendulum myograph), manometers, etc. The laboratory also contains, among objects of special interest, a large tank for administering to animals air or oxygen, compressed under many atmospheres of pressure ; an air-pump for experiments upon animals with rarefied air ; hot air chambers for the study of the effect of external heat on body temperature ; large automatic models of the heart and spinal cord, and of the mechanism of gland secretion, urine secretion and micturition, etc., etc.

There is also a museum of comparative physiology, including a valuable series of casts illustrating the comparative anatomy of the brain. The laboratory is furnished with special vivisection tables, work benches, abundant gas and water supply, artificial respiration apparatus, etc. It communicates by an elevator with the extensive animal rooms on the basement floor and with the photograph rooms on the fifth floor. The accompanying photogravure represents the south end of the main Physiological Laboratory, and shows some of the wall cases, apparatus and automatic models.

The fourth floor is filled by the Department of Pathology and Biology. In the rear is a students' Pathological-room corresponding exactly in size and equipment with the students' Histological-room on the floor below. In the front are a large general Pathological Laboratory, with two smaller rooms for private research opening from it. This laboratory contains an extensive and varied collection of tissues in illustration of Normal and Pathological Histology, to which additions are constantly being made by the Directors in their service as Curators to Charity and Bellevue Hospitals. There are also a number of high-power microscopes, section-cutters, and a glass-blower's table.

The fifth floor contains the Department of Bacteriology, the Museum, and a number of small rooms arranged for gen-

Physiological Laboratory.

eral photography, photo-micrography, lantern projection, tissue injection, etc.

There is also an animal room fitted with cages for the smaller animals under experimentation.

The Bacteriological rooms contain a very complete collection of cultures and of culture apparatus, with all the improved appliances for maintaining continuous and uniform temperature.

The Museum is filled with cases holding a general anatomical and pathological collection.

In the basement, besides the engine room, boilers, etc., are large animal rooms fitted with zinc-lined cages for cats, rabbits, monkeys, etc. In the yard to the rear of the laboratory building is a large dog room, heated by steam, lighted and aired by skylights and capable of accommodating thirty dogs.

Simultaneously with the building of the Loomis Laboratory, the college buildings proper were entirely remodeled and adapted to communicate with the laboratory on every floor. A second lecture hall capable of holding 500 students was constructed, and the section-rooms and other apartments in the college buildings were greatly increased in number and enlarged. The three buildings of the Dispensary, the College, and the Loomis Laboratory, now form a most complete and commodious structure, admirably adapted for the constantly improving system of instruction maintained by the University Medical College.

The functions of the Loomis Laboratory are four-fold:

First.—To afford every means for practical laboratory work to all students early in the course of their medical study.

Second.—To offer facilities and encouragement to advanced students and graduates for the prosecution of original research and experimentation. It frequently happens that physicians desire to make a few laboratory experiments or vivisections themselves, in order to confirm

some new observation or theory. The laboratory furnishes them with animals and apparatus for any desired length of time, and in the brief period since it was opened, a number of physicians have availed themselves of its privileges for a few weeks or months.

Third.—To afford a depository for the collection of apparatus, models, reagents, and specimens which are of use or interest in connection with medical science.

Fourth.—To be of direct public benefit as a centre for the investigation of the many problems relating to sanitation, public hygiene and public health, such as the analysis of contaminated waters, and of adulterated foods and drinks and drugs, of the bacteria of contagious and infectious diseases, etc.

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PATHOLOGICAL LABORATORY.

THE CENTRE FOR VISION.

Being an investigation into the occipital lobes of the dog, cat and monkey.

W. GILMAN THOMPSON, M. D., Professor of Physiology in the Medical Department of the University of the City of New York, and SANGER BROWN, M. D.

The experiments here recorded were conducted in the Loomis Laboratory with the intention of determining the relation which the occipital lobes bear to vision in the dog, cat, and monkey respectively.

Notwithstanding the careful and elaborate experiments made by Prof. E. A. Schäfer and Dr. Sanger Brown,* and earlier experiments by Munk, all of which appear to prove conclusively that the visual centre is situated in the occipital lobe, Dr. Ferrier still maintains—not as he at first declared, however,—that "greater relative disturbances of vision occur from lesions of the angular gyri than from much more extensive lesion of the occipital lobes."†

Tamburini and Luciani‡ have also made very elaborate experiments on dogs and monkeys, from which they conclude that while the vision centre was mainly concentrated in the occipital lobe, it radiated forward with decreasing potency over an indefinite cortical area, a doctrine which they advocate as a general principle of localization.

Goltz, who has always opposed the doctrine of localization, especially as set forth by Munk, has recently per-

* An investigation into the occipital and temporal lobes of the monkey's brain. Philosophical transactions of the Royal Society of London, 1888, vol. 179, B., pp. 303–327.

† Brain, April, 1888, p. 27.

‡ Luciani and Tamburini, "Sulle funzioni del cervello; seconda communicazione," cerebri psico-sensori corticali, 1879 (abstract in Brain, Vol. VII.).

formed additional experiments on dogs, with the apparent purpose of supporting his earlier position. As if fearing he might be obliged to agree with Munk, he removed the eyes before removing the occipital lobes, and then compared the dog so operated on with one which had the eyes only, removed. He concluded that the latter responded much more promptly to the environment than the former.*

Incidentally our researches have raised the question of decussation at the chiasma in dogs and cats, and they seem thus far to support the view, that it is complete. Experiments on this point have previously been made, for the most part, by tracing backward from the eye the effects of enucleation or disease of that organ, and also by division of the chiasma, by cutting through the roof of the mouth. The recent extensive researches of Michel† appear to indicate that in the human subject the decussation, while very variable in amount, is greater than has generally been supposed. Nearly all experimentors differ both from anatomical and physiological standpoints, as to the amount of decussation.

We have also felt the importance of exciting interest in this country in this method of investigation, because statements have been made in various quarters‡ regarding the comparative value of the physiological and the clinical method of studying localization, in which the former method was relegated to a far lower position than would have been assigned to it, if the critics had been practically familiar with this particular department of experimental physiology.

We fear that our deficiency in this regard has to some extent left the profession unable to fairly criticise the

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* Ueber die Verrichtungen des Grosshirns. Goltz, VI. Abhandlung. Pflüger's Archiv. B. 42, Heft 9, 10 (abstract in American Journal of Psychology, August, 1888).

† Ueber die Sehnerven Degeneration und Sehnerven-Kreuzung. Prof. Dr. Julius Michel. Wiesbaden, 1887.

‡ Sajous. Annual of the Universal Med. Sciences, 1888, Vol. I., p. 2.

work of foreign experimentors, and to rightly estimate their conclusions and hypotheses.

Sometimes there has been too much and sometimes too little credulity, and prevailing views have depended largely upon the skill in logic. and power of expression, of their advocates. We feel it highly important that more experimental work of this nature should be conducted in this country. In view of the controversies which investigations in cerebral localization have frequently occasioned, it seems desirable to describe our experimental methods in detail. We have, moreover, taken great pains to demonstrate the results of the lesions produced, to as many observers as possible. Many of the animals were tested in regard to their vision, at a meeting of the Fortnightly Medical Society, held at the Loomis Laboratory on October 13th, 1888, and many of them were presented at a stated meeting of the Neurological Section of the New York Academy of Medicine, held on November 9th, 1888. The animals were frequently tested in the lecture room before large classes. Moreover, while in the laboratory, the animals have all been tested from time to time by many physicians especially interested in the subject under discussion, and no exceptions were taken to any of the results of experiments as herein reported. Under all these circumstances, it is impossible that any preconceived views or any element of "personal equation" on the part of the experimentors should bias the observations described.

Methods of Testing the Sense of Sight.

Unless extreme care is used in testing the vision of the lower animals, it is very easy to form hasty and erroneous conclusions. For this reason the precautions taken in the present series of experiments are fully cited.

The habits of each animal selected for experimentation should be carefully examined and studied for some days prior to operation, and any peculiarities, such as difference to

reaction of sensation on opposite sides, are recorded ; and then after the operation, such tests as the ingenuity of the experimentor may devise, will enable him to determine what has been the result of the lesions, by comparing the animal's later with its former response to its environment. Cats, especially, when really blind, often appear to see, for their senses of smell and hearing and touch are very acute, and very prompt in exciting reflex action. Cocaine may be applied to the nostrils to diminish smell. Hearing cannot well be diminished, but every precaution must be used to secure a quiet room. The "whiskers" should be cut close, but even then, it is doubtful whether the animal does not feel currents of air, which give warning of its approach to solid bodies. It is important to observe the animal in a room with which it is entirely unfamiliar. Dogs and cats will sometimes move about without mishap in a room where they are at home, though they may be totally blind. We have frequently tried bandaging the eye on the side of normal vision, but the objection to the method is, that it takes a day or two for the animal to become accustomed to the adhesive plaster or bandage, and it will usually spend the time in trying to remove it, and ignore special tests. We have often obtained the most reliable results from turning the animal loose in a strange room, carefully watching it for a long time. Much time and patience are required for this, but the results are rewarding. Special tests are also useful, such as drawing a white mouse, alive, tied by a string in front of a cat, or dangling a bit of cotton from a string attached to a long stick, so as to approach the eye from above, and from either side, in turn. A cat may be placed on a large inclined board, studded with tacks placed a couple of inches apart. As the cat walks down the incline, she steps on the heads of the tacks if she fails to see them, and she will walk directly into a basin of water at the foot of the incline. A cat is very well tested by a dog, and conversely. These animals usually watch one another with so much suspicion, that if a cat be placed

on a small table, and a dog walks around the base of it, it is very easy to see when he passes into her field of vision. An excellent test is to place foods of various kinds at some distance in front of a fasting animal. We have often seen a dog blind in one eye, start for a distant piece of meat which is within range of the unaffected eye, and on the way lose sight of it, because he has not yet learned to judge of distance with only one eye.

Method of Operating.

Since cerebral surgery is now so well understood, it is superfluous to describe here all the details, but it is only fair to state that the recent great advances in surgery of the brain had their origin as an incident of physiological experiments upon animals.

Strict antisepsis should be used. Carbolic acid for the instruments, and weak corrosive sublimate, 1-8000 (warm), irrigation for the wound, give the best results. If too strong antiseptics are used on the brain tissue the wound never heals well. It is difficult to cleanse the thick hairy scalp. It should be close-shaven, and thoroughly carbolized. It is well to cover the animal with warm cloths during the operation, to diminish shock. Having felt the distinct median longitudinal bony ridge (so prominent in all cats' and dogs' skulls), and the posterior occipital ridge which crosses it at a right angle, a crescentic incision, an inch and a half long, is made in this angle. If there is much muscle beneath, it may be excised entirely. An opening is then made in the angle formed by the bony ridges. This opening should be equidistant from the two ridges, and not less than one-third of an inch from each, to avoid hemorrhage from opening a sinus, or other large vessel. A half-inch trephine gives ample room for excision of the brain in most cases. If the exact position of the convolutions is uncertain, it is easy to enlarge the opening anteriorly by bone-cutting forceps. After removing the button

of bone (which is frequently less than $\frac{1}{12}$ inch thick), hemorrhage should be controlled before proceeding further. Pledgets of cotton, or of decalcified bone shavings, may be crowded in between the outer and inner tables of bone. The dura mater is next raised by a hook, and cut away with scissors, or it may be reflected as a flap and replaced. A scalpel is used to cut out sharply the desired quantity of brain tissue, and a small scoop (such as is used for scraping necrosed bone), is very convenient for removing it. The hemorrhage which immediately follows may be controlled by warm corrosive sublimate irrigation, but it is usually necessary to pack the wound with a compress of antiseptic cotton, which is removed when the bleeding ceases. It is exceedingly desirable to have the hemorrhage entirely checked before closing the wound, otherwise the healing is retarded. The wound is next sprinkled with iodoform and the skin is sewed. Thorough irrigation during this part of the operation is desirable. The wound is then dried with warm cotton, and covered by four or five successive layers of antiseptic gauze, each soaked in collodion, which should be much thicker than the officinal preparation. If the animals be held until the collodion has firmly dried, the dressing is almost never torn off by them later. After four days the dressing may be removed by moistening it with ether. It is best to leave the stitches for a few days longer. We have found this form of dressing to be almost the only one which the animals cannot remove. Dogs are very apt, after cerebral operations, to rub the head upon the floor, but if thoroughly dried, the collodion gauze is rarely disturbed. Any drainage of the wound would be well-nigh impossible with restless animals, and since the nearly uniform result of our operations was union by first intention, drainage was unnecessary. In one or two cases we replaced the button of bone in the trephine opening, and left it there. There is no advantage in this procedure. The button is apt to slip, and, turning end-wise, to cause irritation. Neither is

there any advantage in sprinkling the powdered bone in the wound, as has been suggested in such cases.

Dogs should always have the hind legs shackled for a few days, otherwise they may rub off the dressing. Cats and monkeys soon become used to the dressing, and do not make persistent attempts to remove it.

It is worthy of note that in every instance where the animals were kept beyond the first few days, they grew stouter and appeared in a perfectly normal condition, excepting as to their vision, (and, in one or two instances, their tactile sensation). This was true even of those cases in which the largest amount of brain tissue was removed, namely, the two monkeys and some of the cats. Repeated tests were made of the senses of smell, taste and hearing, but no impairment could be discovered.

No anæsthesia of the cornea was noticed, and no abnormality of the pupils, excepting in a single instance. During the operation it is important to have the head held firmly. For this purpose we used a small metal cylinder, one end of which fits over the animal's nose and mouth; the other end admits a sponge wet with ether (see plate with monkey in position). The cylinder is soldered to two transverse metal bars, which slide up and down on perpendicular rods. In this way the cylinder is supported firmly at any convenient elevation. A stout brass wire, bent in horse-shoe form, slips beneath the animal's occiput, and being held by its ends with binding screws to the transverse metal bars, it prevents the animal from withdrawing its nose from the cylinder. This simple apparatus was modified by Dr. Brown from a similar one in use by Prof. Schäfer, in the Physiological Laboratory of the University Medical College, London.

HISTORY OF EACH OF THE TWENTY-SIX OPERATIONS.

Cats.

No. 1.—Adult female. A half-inch button was trephined immediately over the right occipital region and 3½ cc. of brain tissue were removed. Upon recovering from the anæsthetic, the animal exhibited marked rotatory movements towards the sound side. No anæsthesia or paresis. Pupils normal. No ptosis. Total blindness of left eye. The animal walked deliberately into any object in her way upon the left side, but avoided it upon the right. Did not wink the left eye when objects approached it, unless the lids or conjuntivæ were touched. The cat made a good recovery from the immediate effects of the operation, but towards the end of the second day, vomiting of bile ensued, with a rise of temperature from the normal (101.5°), to 104.2°. Despite careful nursing, the animal grew worse, and although antiseptics were used in the operation, suppuration was suspected, and on the fourth day the animal was killed by chloroform. Total blindness of the left eye persisted until death.

Autopsy.—Slight suppuration was found in the edges of the wound. No pressure, apparently, had been exerted on the brain surface, which appeared normal. No cerebral hernia. A superficial lesion is found affecting the second and third right occipital convolutions posteriorly. The first occipital convolution is normal. Diameters of the lesion: Antero-post., 2.1 cm.; transverse, 1.2 cm.; vertical, .8 cm.

No. 2.—Large female; pregnant. A half-inch button was trephined immediately over the left occipital region, and about 6 cc. of brain substance were removed. The operation was delayed by considerable hemorrhage, both from the bone and from the brain. The cat was kept one hour under ether, and she lost about two ounces of blood. Half an hour later the rectal temperature had fallen from normal (101.5°), to 97.6°, but the cat got up and walked about, showing slight rigidity of the right hind leg, and the head was rotated towards the right. There was total blindness of the right eye. Vision normal with the left eye. Both right legs were partially anæsthetic; the right ear and right side of the face were completely so.

The animal made an uninterrupted recovery. The wound healed readily by first intention. In three days the cat appeared perfectly well, save the anæsthesia and blindness. In lapping milk the cat turned the head well over towards the right, although there was no deviation of the tongue. In five or six days anæsthesia was greatly lessened, especially in the right feet, and the movements of the head became normal. No rigidity or paresis. The pupil of the right eye was about twice the size of the left pupil, and it so remained during the animal's life. Both pupils reacted well. Careful opthalmoscopic examination of the eyes on the 17th day, revealed nothing beyond the excessive amount of pigment which is common to normal cats' eyes. Retinal vessels normal. On the 34th day, the animal was still totally blind in the right eye. She was tested by bandaging the normal eye, and showing her a saucer of milk when hungry, to which she paid no attention until the bandage was removed

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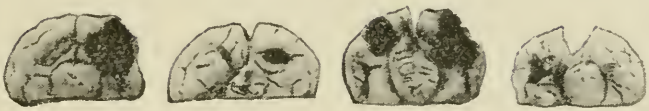

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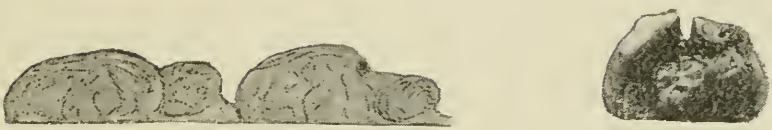

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CATS' BRAINS.

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from the normal eye. A dog, for which she had an intense antipathy, excited no attention on the right side, but provoked immediate growls when seen on the left, or in front. Similar tests were made by dangling cotton on a string, approaching the eyes with sharp objects, etc. In every instance the cat proved totally blind in the right eye, and saw perfectly with the entire field of the left eye. She was delivered in the previous week of four healthy kittens.

On the 63d day, vision was again tested, with identical result. Slight anæsthesia still remained over the entire right side, face, legs and body. General health good, but the cat was somewhat exhausted by nursing. Two kittens were therefore removed.

On the 78th day, the animal was exhibited to the Fortnightly Medical Society, and her condition of total blindness of the right eye, and perfect vision of the left eye, was demonstrated to the satisfaction of all present. A second opthalmoscopic examination showed nothing abnormal. On the 105th day (November 9th, 1888), the animal was exhibited at a stated meeting of the Neurological Section of the N. Y. Academy of Medicine, and her condition, as herein reported, was endorsed. On the 232d day, there was no further change of any kind. Opthalmoscopic examination was entirely negative. The animal saw a live rat at once with the left eye, and noticed pieces of cotton moved by strings, etc., but when the left eye was covered, there was total blindness on the right side, as before. The anæsthesia had diminished considerably. On the 341st day, the anæsthesia was almost gone, the right pupil still remained dilated, and there was no vision with the right eye. The cat was then killed by chloroform.

Autopsy.—Weight of cat, 7⅝ lbs.; weight of entire brain, 24 g. The button of bone which had been trephined and replaced, was found turned at a right angle to the cranial surface, projecting downwards into the lesion, and fixed in that position. The entire left occipital lobe seemed to have softened and formed a large cavity, the walls of which collapsed on opening the skull. The cavity contained a little serum, but no pus. There was complete degeneration and atrophy of the left anterior corpus quadrigeminus.

No. 3.—Large female. A half-inch trephine was used, and 2 cm. of brain were removed from the right occipital region. On recovering from the anæsthetic, the animal was very delirious and rushed madly about the laboratory, biting her own legs. There were distinct rotatory movements towards the side of the lesion. On the second day, the animal recovered sufficiently to have her vision tested, and the left eye proved totally blind, the right eye normal. In walking on a table, the cat constantly tended to fall off on the left side, and if not guarded, would tumble to the floor. No anæsthesia of the skin. During the operation the cat's temperature fell from 101.5° to 99°. On the third day the temperature rose to 102.8°, suppuration appeared in the wound, and numerous unilateral epileptiform convulsions occurred, affecting the left side. The convulsions became so frequent that on the 4th day the animal was killed.

Autopsy revealed a lesion of the right occipital lobe, involving the bend of the 1st and 2d convolutions. The lesion is somewhat pear-shaped, with apex

directed downwards and backwards. Diam. antero-post., 0.7 cm.; trans., 0.8 cm.; depth, 0.5 cm.

No. 4.—Large female. The operation was entirely similar to No. 3, except that 3 cm. of brain were removed on the right side, posteriorly. Total blindness of the left eye resulted immediately; the vision of the right eye remained perfect. There was rotation towards the sound side, partial anæsthesia of the left ear and left side of the nose.

The animal was killed on the 4th day.

Autopsy—showed a lesion of the right occipital region far back, involving the 1st, 2d, and part of the third, convolutions. Diam. antero-post., 1.8 cm.; trans., 2 cm.; depth, 0.7 cm. (not photographed).

No. 5.—Kitten 3 months old. A quarter-inch trephine was used, and 1 cm. of brain was removed from the left occipital region. Total blindness of the right eye resulted. Vision of left eye normal. The kitten seemed feeble after the operation, and although there was no suppuration, she was killed on the 2d day.

Autopsy.—Lesion involves post. part of 1st and 2d left occip. gyri, including a small portion of the mesal surface of the hemisphere. The margins are irregular and ragged. Diam. antero-post., 0.9 cm.; trans., 0.8 cm.; depth, 0.5 cm.

No. 6.—Small female. A double operation was performed, both lesions being very superficial, not over 5 cm. deep, and 1 cm. broad, in each occipital region. Immediately after the operation the cat could see fairly well about the laboratory with both eyes. The wound healed without suppuration. On the 6th day, sight being apparently quite normal in both eyes, the animal was killed, as it was wanted for other experiments.

Autopsy.—*Right side.*—A shallow, slit-like lesion involves the poster. extremity of first, and part of inner margin of second, occipital gyrus. Diam. trans., 0.9; antero-post. 0.4; depth, 0.1 cm.

Left side.—Lesion involves contiguous margins of post. part of first and second occipital gyri. Very little cerebral substance appears to have been removed. Diam. antero-post., 0.4 cm.; trans., 0.2 cm.; depth, less than 0.5 cm.

No. 7.—Large female. In this case a double operation was performed, as in No. 6. A quarter-inch trephine was used on both sides, and a piece of brain tissue about .8 cm. broad by .4 cm. deep was removed, slightly more being taken out on the left, than on the right side. On both sides the lesion was made at the posterior margin of the occipital region. The animal made an excellent recovery from the operation, but superficial suppuration occurred in the wound on the 3d day. The temperature rose to 106.4°, and on the 8th day an abscess of the scalp was incised and irrigated. After this no further pus formed, and the scalp wounds closed perfectly. On the 3d day the cat was totally blind in both eyes. She walked down an inclined plane directly into a pail of water. After repeating this trial she stopped at the foot of the board, and groped about blindly until her paw felt the edge of the pail, when she

stepped upon it and leaped off. She would walk directly off from the end of a table, and would walk straight into a chair-leg, or the wall, until she bumped her nose.

On the 8th day, she was still totally blind. On the 11th day, vision began to return a little in the left eye (the side opposite the smaller lesion). Tested by white mouse, cotton on string, etc. Totally blind in right eye. The cat had diarrhœa and bronchitis, and was quite ill for a day or two, but with careful nursing, she soon recovered completely. On the 15th day she was well and lively. She saw a little with both eyes, enough to tease a pigeon and play with a dog. 30th day, vision of left eye was apparently normal. In the right eye vision seemed about half normal.

It is very difficult with cats—much more so than with monkeys—in cases of partial vision, to determine which quadrant of the visual field is not perceived. This is due to their relative dullness, and lack of interest in the various tests employed. In this case, all that could be determined was that vision was less acute upon the right side.

60th day, exhibited to Fortnightly Medical Society. Vision perfect, except trace of impairment for right visual field. Health perfect.

87th day, exhibited at New York Academy of Medicine. Condition unaltered. No anæsthesia at any time. On the 184th day, opthalmoscopic examinations revealed nothing abnormal. On the 190th day, the animal could see a rat plainly across the room. A trace of impairment of right visual field still existed, but the cat saw well on either side of the median line. The trephine openings could no longer be felt through the scalp. The cat was evidently pregnant, and a few days later she was delivered of four kittens. On the 226th day, vision appeared perfect in both eyes, and the cat was killed by chloroform.

Autopsy.—Weight of cat 7⅝ lbs.; weight of entire brain 24.65 g. The trephine openings (shown in the photograph with the brain), were partly closed. On the *right side*, a small lesion 0.6 cm. in diam. and 0.2 cm. deep, was seen, which involved the post. bend of the 1st and 2d occipital gyri, without involving the mesal surface. On the *left side*, a shallow lesion was found in the 1st and 2d occip. gyri, measuring 0.8 x 0.6 cm., and 0.3 cm. in depth.

No. 8.—Kitten, 5 months old. Two cc., of brain tissue removed from left occipital region, far back. The animal nearly died under ether, but was restored by artificial respiration. The wound was found on the fourth day perfectly healed. No suppuration at any time. Totally blind in the right eye. Left side, vision normal. 10th day, left eye carefully bandaged by a hood sewed over the head. Right eye almost totally blind to all tests, as white mouse, dog, etc. Smelled the dog, and seemed afraid, but did not strike at him or know where to go to escape him, unless he came within range of external half of right retina, when he was apparently imperfectly seen. The kitten walked on the edge of a table, and constantly slipped off on the right side. No anæsthesia. 36th day, vision entirely normal in both eyes. A laparotomy was performed, from which complete recovery resulted. 54th day, exhibited

to Fortnightly Medical Society. 81st day, exhibited at the New York Academy of Medicine. Had grown to be a large cat. Vision completely normal. Opthalmoscopic examination, made on the 176th day, revealed nothing abnormal. On the 199th day, vision was still entirely normal, and the cat was killed.

Autopsy.—Weight of cat, $7\frac{15}{16}$ lbs.; weight of entire brain, 24.55 g.; lesion of left occipital region, involving bend of first and second occipital convolutions; diam. antero-post., 1.5 cm.; trans., 1.6 cm.; depth, 0.6.

No. 9.—Large male. From the right occipital region, 2 cc. of brain tissue were removed, and from the left side, 1 cc. A quarter-inch trephine was used. The operation lasted 15 minutes, and in half an hour the animal was walking about. On the third day, the wound was healing well without suppuration. On the fourth day the animal was totally blind in both eyes (as, of course, it was immediately after the operation). He walked into everything which stood in his way, stared about aimlessly, walked down an incline into a pail of water, etc. Did not see a dog or pay any attention to him. Previously the animal always showed great antipathy to the dog. On 6th day, still totally blind. 7th day, very carefully tested. If placed on a table he fell off constantly on the left side, (opposite the greater lesion). No response to cotton on string, the hands, or any object placed on left side. If the hand was held on the right, and a little below the edge of the table, the cat at once rubbed his head playfully against it, and purred. He also saw a white dog below him, and on the right of the table, and he followed cotton drawn past the right side. If the cotton was swung by a string in a circle, he followed it all around with the right eye, turning the head, and tried to catch it. He started to go towards several objects and lost them on the way. All the tests demonstrated clearly that objects were only seen when placed below, and to the right of, the visual axis of the right eye; that is, there was blindness everywhere, excepting in the internal upper quadrant of the right eye. 36th day, vision was very fair in both eyes. It was not easy to detect any blindness at all, though in a general way, vision seemed less acute than normal. 44th day, shown to Fortnightly Medical Society. Ophthalmoscopic examination revealed nothing abnormal. 71st day; during the past month the cat was very surly and vicious, which was a marked change from a previously placid temperament. Shown at the New York Academy of Medicine. Vision appeared entirely normal, excepting very slight impairment in the left eye. The cat had grown very large and vigorous. On the 186th day, the animal was found to see perfectly with the right eye, but the left eye was still partially blind. The cat was then killed.

Autopsy.—Weight of cat, $9\frac{1}{2}$ lbs.; weight of entire brain, 24.11 g. The pia mater is found adherent, and greatly thickened, over the region of the greater lesion and contiguous to it. The lesion of the *right* occipital region involves the first and second occipital convolutions, and the inner margin of the third, at their bend. It is clean-cut and pyramidal in shape. Diam. antero-post., 0.7 cm.; trans., 0.7 cm.; depth, 0.4 cm. The *left* lesion involves the outer part of the first, and inner part of the second, occipital convolutions, just anterior to the bend. Diam. antero-post., 0.5 cm.; trans., 0.5 cm.; depth, 0.3 cm.

No. 10.—Large male. Two buttons were removed with a quarter-inch trephine, one over each occipital region, and 2 cm. of brain were excised from each side. There was excessive hemorrhage, both from the bone and the brain, and ℥ iv. of blood were lost. The animal bore the operation very poorly, and the temperature fell from 102.5° to 94°. On recovering from the anæsthetic the cat was very wild, scratching and crying, if disturbed. There was total blindness of both eyes, on the 2d day, and also slight anæsthesia of the entire left side. Marked rotation towards the left side, which increased, so that on the 3d day the cat could lie only upon the right side. If disturbed or lifted by the nap of the neck, the animal rolled over and over towards the left with great violence. If stopped when half turned over, he pushed and scratched until rotation was complete, and he lay again at rest upon the right side. He was very dull and somnolent. He refused nourishment, or, rather, was unable to take it on account of the rotation of the body, and constant twisting of the neck towards the left. Died on the 3d day.

Autopsy.—*Right Side.* Lesion involves the post. part of the 2d occip. gyrus. Diam. antero-post., 1.5 cm. (somewhat oblique from before, backwards and outwards); trans., 0.8 cm.; depth, 0.3 cm.

Left Side.—Lesion oval in outline, small and very shallow. Diam. antero-post., 0.7 cm.; trans., 0.85 cm.; depth, 0.2 cm. The lesion involves the bend of the 2d occipital gyrus only. Mesal surface of hemisphere and adjoining convolutions normal. There were acute congestion and slight hemorrhage over the meninges of the entire cerebellum, especially marked on the right side.

No. 11.—Kitten four weeks old. About 2 cc. of brain substance were removed in the left occipital region. The kitten was able to walk after the anæsthetic was discontinued, and was totally blind on the right side. Vision in left eye normal. The temperature, however, fell from 103° before the operation to 91.5° F. The animal was too feeble to suckle, and it died on the second day, of exhaustion.

Autopsy.—The opening in the skull, made by a scalpel, is shown in the photograph with the brain. A small circular lesion, about 0.7 cm. in diameter, and 0.2 cm. deep, was found at the bend of the first occipital convolution, grazing the second convolution.

No. 12.—Large male. On this animal a double operation was performed, about 2 cc. of brain substance being removed from each occipital region, through ¼-inch trephine openings. A little more was cut from the left, than from the right side. Total blindness in both eyes resulted, with total right-sided hemi-anæsthesia of body and legs, and partial right facial anæsthesia. There were marked rotatory movements towards the right for some hours after the operation. On the 2d day, the animal sat with his head towards the right, and, if urged to stand, turned in that direction. He had some diarrhœa, and was weak and ill. There was a spastic condition of the flexors of the right fore leg, and to a less degree, of the right hind leg. The toes were flexed, and the cat stepped on the dorsum of the foot. 4th day, condition found improved. The cat walked about voluntarily, turning to the right, and walking

directly into the wall. He paid no attention to a dog, until he smelled him. When the dog put his face very near, the cat struck at him, using the left paw only, and without seeing him. The cat walked off a table, and fell to the floor, walked down an incline, and fell on the right side in a pail of water. He struggled up again, and shook both left feet vigorously, and rested them on the edge of the pan, but left both right feet standing in the pan, quite unaware that they were wet. If the left feet were pushed back in the pan, they were removed and vigorously shaken again, as soon as they touched the water. The animal clearly was completely blind in both eyes. 8th day, anæsthesia slightly lessened. The animal was exhibited in the lecture-room, by placing it in a large shallow tray of water. The two normal feet were at once withdrawn and shaken, the two right feet were left in the water. The cat groped about, trying to find a dry place. He could not see the water, but on dipping the nose in it, he would suddenly raise the head and try another place. The wound had healed admirably without suppuration. On the 9th day, a very little vision was detected in the external half of the left retina. On the 10th day, he saw so well as to grope his way about much more freely, turning the head so as to bring objects within the field of the external half of the left retina. 11th day, the cat was exhibited to the Fortnightly Medical Society. In the pan of water he still showed the hemi-anæsthesia as before, but he could see the water in time to avoid dipping his nose into it. No changes in the eyes were found by ophthalmoscopic examination. On the 37th day, he groped about the laboratory very well, occasionally striking the right side, however, against various objects. On a table, he always turned towards the right side, evidently seeing the danger of falling off on the left side, but not upon the right. He jumped fairly well, saw a dog, and a saucer of milk. The anæsthesia had completely disappeared. On this 37th day, he was exhibited at the New York Academy of Medicine. On the 95th day, an opthalmoscopic examination was made by Prof. C. S. Bull, and it was observed that the temporal half of the left optic disc was discolored, and its vessels were paler than the normal, and diminished in calibre. The opthalmoscopic examination of the right eye showed nothing abnormal. On the 102d day, the cat failed entirely to see a live white rat, even when close to it. The cat walked into every object in its way. On the 209th day, the blindness was still complete upon both sides, excepting the external half of the left retina, and the cat was killed by chloroform.

Autopsy.—Weight of cat 10½ lbs.; weight of entire brain, 25 g.

Right side.—Lesion oval, involving 1st and 2nd occipital convolutions posteriorly, reaching to the mesal surface. Diam. trans, 1.1 cm.; antero. post., 0.6. cm., depth, 0.3 cm.

Left side.—Lesion oval, involving bend of 2d occipital convolution, alone. Diam, trans. 0.8 cm.; antero post., 0.5 cm., depth, 0.3 cm.

No. 13.—Kitten 2 months old. 1 cc. of brain substance was removed from the right occipital region. On the 2d day, there was partial blindness of the left eye. The wound healed without suppuration. 14th day, sight was found improved. 27th day, the animal was exhibited at the New York

Academy of Medicine. Vision normal. Followed a rat all about the laboratory. On the 167th day, the animal had grown to be a large cat, and vision remained normal in both eyes. She was then killed by chloroform. (Not photographed.)

Autopsy.—Weight of cat, 5⅝ lbs.; weight of entire brain, 23.51 g.

A small conical lesion was found involving the 2nd right occipital convolution, at its posterior bend. Diam. 0.3 cm., depth, 0.1 cm.

No. 14.—Small female. A ¼-inch trephine was used, and 2 cc. of brain substance were removed from each occipital region. The following day the cat was totally blind in both eyes. She groped her way cautiously about, nose to the ground, and walked directly into any object in her path. Exhibited in the lecture-room, she deliberately walked off a high table a number of times. There was very slight right hemi-anæsthesia. No paralysis. The wound healed well by first intention. On the 81st day, the cat was still completely blind in both eyes. The anæsthesia disappeared. She is still alive.

No. 15.—Large male. A ½-inch trephine was used, and 3.5 cc. of brain substance were removed from the left occipital region. Total blindness of the right eye resulted, with normal vision in the left eye. The animal is still alive.

Dogs.

No. 1.—Large male, mongrel. A half-inch trephine was used on the right side, and about 5 cc. of brain substance were removed from the right occipital region, far back. The operation lasted an hour, for the cerebral hemorrhage was severe. It was controlled by antiseptic cotton tampons, crowded into the cavity. Half an hour later the dog recovered, ran about, and recognized the Janitor, following him about. No anæsthesia.

2d day, a plaster was fastened over the right eye, when the dog ran into stools, tables and everything in his way. He followed the Janitor by scent and voice, but could not see him. He bumped his head severely several times against obstacles imposed in his way; he was very lively, and ate well. On the 4th day, he had slight fever and slight suppuration was found in the wound, for he had succeeded in partially removing the dressing.

6th day, no anæsthesia, totally blind, as before, in the left eye. The dog seemed ill, so he was killed by chloroform.

Autopsy.—Brain, longitudinal diam., 5.2 cm.; transverse diam., 5. cm. In right occipital region at post. border is a ragged cavity measuring 2 cm. in trans. diam. by 1.5 cm. in depth anteriorly, and 1.9 cm. posteriorly. The cavity occupies the 1st and 2d occipital convolutions only; the 3d and 4th are entirely normal. On the top of the 2d convolution, anterior to the cavity, is a small cerebral hernia 1.2 cm. in diameter.

No. 2.—Very large mastiff. A half-inch trephine was used, and the opening was enlarged to the diameter of an inch by bone forceps. 8 cc. of brain substance were removed from the right occipital region. During the day, the dog rotated towards the sound side. On the 2d day, his motions were normal;

he ran into everything on the left side. Despite every precaution he laid his wound bare by rubbing his head on the ground, and, of course, suppuration ensued. On the 7th day, he was still totally blind upon the left side; vision normal on the right. He was then killed.

Autopsy revealed a lesion of the right occipital region irregularly quadrilateral in shape, measuring 2.5 cm. in antero-post. diam., 2 cm. in trans. diam. and 1.5 cm. in depth. The lesion was very ragged. The 1st, 2d and 3d convolutions were all involved.

No 3.—Large male cur. Half-inch trephine, 6.5 cc. of brain substance were removed from left occipital region. Total blindness of the right eye resulted. On the 4th day, the animal was well and lively, and still totally blind on the right side; vision normal on the left side. He was then killed.

Autopsy.—Lesion roughly quadrilateral, with a projection at its antero-external angle. Mesal surface of brain uninjured, except at one point near the anterior extremity of the lesion. Lesion involves external part of 1st and entire post. part of 2d and 3d convolutions in left occipital region. Diameters, antero-post., 2.8 cm.: tranverse, 1.6 cm.; depth, 1.4 to 2 cm.

No. 4.—Small male cur. About 3 cc. of brain tissue were removed from the left occipital region, through a ¼-inch trephine opening. Complete blindness of the right eye resulted; the vision was normal on the left side. The dog was given a large dose of morphine instead of ether (which was used in all other cases), and he died in 10 hours as a result of this treatment; he became maniacal, and had general convulsions.

Autopsy reveals a long, narrow, wedge-shaped lesion, wider anteriorly, involving the posterior part of the 2d convolution in the left occipital region. Diam. antero-post., 2.4 cm., trans., .9 cm., depth, .6 cm. The anterior limit is .5 cm. in front of the upper extremity of the Sylvian fissure.

No. 5.—Large bull-dog bitch. A ¼-inch trephine was used, and 4.5 cc. of brain were excised from the left occipital region. Twenty minutes after the operation the dog ran all about the laboratory, bumping into everything upon the right side; the vision was normal on the left side. The wound healed well, without suppuration. 8th day, still totally blind in the right eye. 28th day, the animal had grown very fat, total blindness of the right eye was found to have given place to very slight impairment of vision. On the 31st day, the animal being perfectly healthy, a second operation was performed, and 1.25 cc. of brain substance were removed from the right side. About ℥ vi. of blood were lost, and the operation was delayed through an hour. On the 32d day, there was total blindness of the left eye. No anæsthesia. Suppuration ensued, and on the 35th day, the dog died of septicæmia. The left eye remained totally blind, and the right eye partially so. Immediately after the 2d operation, there was rotation of the body towards the left side. No rotation had occurred previously.

Autopsy.—*Left occipital region.*—Quadrilateral lesion involving post. half of 1st, post. two-thirds of 2d, and bend, or knee, of 3d occipital convolutions. Anter. limit 1.2 cm. in front of upper extremity of Sylvian fissure, extends at deepest part, to tentorium cerebelli. Diameters, trans., 2. cm., antero. post.,

DOGS' BRAINS.

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2.6 cm., depth, 2.6 cm. A piece of dura mater, with a layer of brain substance adherent to it, covers the lesion.

Right occipital region.—Lesion much smaller than left, involving bend of 2d and small part of bend of 1st, occipital gyri, wider posteriorly. Diam. antero-post., 1.9 cm., trans. 1.0 cm., depth, .7 cm.

No. 6.—Black-and-tan male. 2 cc. of brain substance were excised from the left occipital region. Immediately after the operation, vision was found normal on the left side, and only slightly impaired on the right side. On the 8th day, the condition of vision was normal in both eyes, and the animal was killed.

Autopsy.—Lesion involves post. part of second left occipital gyrus, is oval in outline, and very shallow, the maximum depth being less than 0.2 cm.; diam. antero-post., 0.7 cm.; trans., 0.5 cm.

No. 7.—Large bull-dog bitch. 5 cc. of brain substance were removed from the right occipital region, through a one-half inch trephine opening. Total blindness of the left eye resulted, and continued for nine days, when sight began to be recovered. Vision in the right eye was normal throughout. No suppuration. No rotation or anæsthesia. 35th day, sight almost completely recovered in left eye. Vision did not seem quite so acute with this eye as with the other, but the animal followed another dog's movements with it. The animal was used for an ovariotomy operation, from which a good recovery was made. On the 49th day, she was exhibited at the New York Academy of Medicine, when there was still a very slight impairment of vision in the left eye. On the 60th day, vision appeared perfectly normal, no impairment being detected by any tests which it was possible to employ. On the 122d day vision still remained normal, and the dog was killed. The animal had gained greatly in weight and size, and was in excellent condition.

Autopsy showed a superficial lesion of the right occipital lobe, measuring 2 cm. in long. diam.; 2 cm. in trans. diam., and 5 in depth. It involved the first and second convolutions, but principally the first, including the mesal surface.

No. 8.—Male, weighing 15 lbs. A large opening in the skull was made, and 6.04 g. of brain substance were removed in one piece, from the right occipital region. Total blindness of the left eye resulted. Vision in the right eye normal. The dog made a good recovery from the operation, but remained totally blind on the left side, until the 4th day, when he was killed.

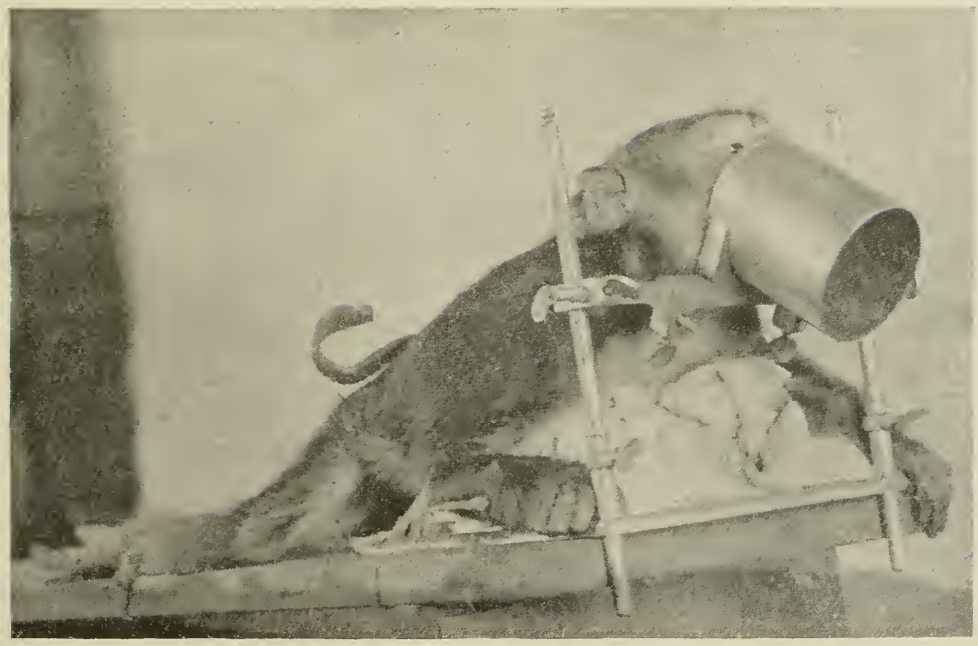
Autopsy.—Very deep lesion in right occipital region, involving first, second and third gyri. Outline pyriform, anter. pointed and poster. wide and rounded; diam. antero-post., 2.6 cm.; trans., 2.1 cm.; depth in centre, 1.8 cm. Anterior limit of lesion, 1.0 cm. in front of upper extremity of Sylvian fissure; mesal surface of hemisphere uninjured, except at one point corresponding to the middle of the lesion. (Not photographed.)

No. 9.—Small male terrier. A half-inch trephine was used, and 4.5 cc. of brain substance were removed from the left occipital region. Total blindness of the right eye, with unimpaired vision with the left eye, resulted. This condition has persisted for thirty days. The animal is alive at the time of writing.

Monkeys.

No. 1.—A half-inch button of bone was trephined over the left angular gyrus, and an equal amount of bone was removed over the occipital lobe. A cut 1 cm. deep, was made in the sulcus between the angular gyrus and the occipital lobe, and 3.47 g. of brain tissue were removed from the latter by a scoop. The animal recovered completely in half an hour, and was bright and lively. During the operation the temperature fell from 102° (the normal), to 98.4° Fahr. In the evening the animal was exhibited to the Fortnightly Medical Society, and a demonstration of his left homonymous hemianopsia was made apparent to all. It was shown by the way in which he followed the movements of a fly as soon as it crossed the median line, and by his failure to see pieces of banana, sugar plums, etc., unless they came within the range of normal vision still remaining. He had partial right hemi-anæsthesia, more marked in the legs, and especially more in the fore-leg than on the body. He held the right fore-leg in a slight "drop-wrist" position, and did not use the right paw for climbing or picking up food, yet he showed no impairment of gait in walking, and seemed to have no paralysis. He tried to pick up food with the right fore-paw but missed it, and then used the left fore-paw. He saw only such objects as were upon the left side. If tied by the waist to a chain passing through a central hole in a table, he could turn about freely in any direction. If a ring of raisins or sugar plums was placed around him, just within reach, he would pick up only those upon the left side, turning gradually completely around the circle towards the left. In making this "food circle" test, it is important to have the animal starved for a day or two previously, so as to make him give his whole attention to the food. If the food be given in small particles only, and scattered about, the manner in which it is invariably picked up, forms as absolutely conclusive a test for hemianopsia as it is possible to obtain with the lower animals. On the 4th day, the dressing was removed. The wound was healed, and the monkey was well and lively, without fever. 15th day, slight anæsthesia and complete left homonymous hemianopsia were found as before. His temper had become very vicious. He was very fierce and snappish. Before the operation he was quite docile. On the 26th day, a demonstration of the hemianopsia was made at the New York Academy of Medicine by the "food circle" test, etc. The anæsthesia was much diminished, and the right fore-leg was used in climbing. On the 93d day, the vision of both eyes was unimproved. Both fore-paws were used equally and normally. On the 100th day, a second operation was performed, in which an opening 2 cm. in diam. was made, and 2.25 g. of brain tissue were removed from the occipital region behind the angular gyrus. Great care was taken not to injure the angular gyrus in any way. Upon recovering from the anæsthetic, the monkey was absolutely blind in both eyes. He groped his way about, and ran into any object in his way. When he fancied he was near the cage from which he had just been removed, he would spring wildly in the air towards it. If he ran into the leg of a table, he would climb up and then fall off again from the top. He could not see his food held in any position. After three weeks, he recovered a very little vision for objects held on the extreme right, but the

BRAIN OF MONKEY No. 1.



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sight on this side remained imperfect. Probably a very few occipital fibres had escaped injury in the second operation. There was no recovery at all of the hemianopsia produced by the first operation. 130th day, condition of blindness unaltered. 150th day, blindness unaltered. The monkey had a good deal of cough, with occasional indigestion and hectic fever. The cough continued, rales developed in the chest, and the animal was evidently suffering from phthisis. Emaciation progressed, the temper became sullen and morose, the animal became dull and inactive, and on the 231st day, he died, weighing only $4\frac{3}{8}$ lbs. The blindness was unaltered.

Autopsy showed general milliary tuberculosis of abdominal and thoracic viscera. The entire occipital lobe behind the angular gyrus upon each side has been removed, leaving a clean-cut surface. For some distance around this surface the pia is firmly adherent to the convolutions beneath, but it is not thickened. Diam. of cut surfaces: left side, trans., 2.1 cm.; vertical, 1 cm.: right side, trans., 2 cm. vertical, 0.9 cm.

No. 2.—A half-inch trephine was applied over the left angular gyrus, which was completely exposed by enlarging the opening. 1.05 g. of brain tissue were removed by cutting out the entire gyrus. The animal recovered in an hour, with normal vision in both eyes, and decided hemi-anæsthesia of both right legs, and none of the face. The monkey was kept over night, sewed in a bag with his head out, to prevent his scratching off the dressing. On the 2d day, he was put with monkey No. 1 and was very demonstrative, with normal vision. Slight paresis and "drop wrist" in the right fore paw. On the fourth day, the dressing was removed and the wound was found healed without suppuration.

23d day, exhibited at the New York Academy of Medicine. Vision was perfect and hemi-anæsthesia was diminishing, with complete return of power in the right arm.

90th day, a second operation was performed by excising the entire right occipital lobe, posterior to the angular gyrus, through an opening 1 x $1\frac{1}{2}$ inches —large enough to expose the convolutions completely. The brain tissue removed, weighed 2.4 g. The result was immediate right homonymous hemianopsia. During the operation the rectal temperature fell from 101° to 94°, but the animal was afterwards nursed in hot blankets, and he made an excellent recovery, with normal appetite on the next day. The animal was completely blind to all objects in the left visual field of each eye, *i. e.*, to all objects on the left of the median plane of the body. On the 119th day an opthalmoscopic examination was made by Prof. C. S. Bull, who found the right eye normal, but in the left eye, there was beginning atrophy of the disc, and the arteries were reduced in calibre. Condition of vision unchanged. On the 137th day, it was found that a bright light suddenly focused upon the right eye caused winking, but when focused on the left eye, no winking occurred; no anæsthesia; no paralysis; right homonymous hemianopsia. One year and five months after the operation the animal is alive and in excellent health, the only symptom being the right homonymous hemianopsia, which is stlil persistent.

TABLE OF TWENTY-SIX OPERATIONS.

Animal.	No. of operation.	Site of operation.	Side of blindness.	Degree of blindness after operation.	Paresis.	Pupils.	Recovery of sight.	Duration of life in days.	Mode of death.	Rotatory movements.	Anæsthesia.
Cat.	1	r.	l.	total	none	normal	no	4	chloroform	towards well side	no
"	2	l.	r.	"	"	r. pupil dilated	"	341	"	"	both r. legs
"	3	r.	l.	"	"	normal	"	4	"	towards lesion	no
"	4	r.	l.	"	"	"	"	4	"	towards well side	total on l.
"	5	l.	r.	"	"	"	"	2	"	none	no
"	6	r. l.	l. r.	"	"	"	"	3	exhaustion	"	slight on l
"	7	r. l.	l. r.	"	"	"	complete	226	chloroform	"	no
"	8	l.	r.	"	"	"	"	199	"	"	"
"	9	l. r.	r. l.	"	"	"	l. normal r. partial	186	"	towards greater lesion	"
"	10	r. l.	l. r.	partial	"	"	nearly perfect	6	"	none	"
"	11	l.	r.	total	"	"	no	2	shock, exhaustion	"	"
"	12	l. r.	r. l.	"	both r. legs.	"	"	209	chloroform	towards greater lesion	total on r.
"	13	r.	l.	partial	none	"	complete	167	"	none	no
"	14	l. r.	r. l.	total	"	"	——	still alive	——	"	slight on r.
"	15	l.	r.	"	"	"	——	"	——	towards greater lesion	no
Dog.	1	r.	l.	"	"	"	no	6	chloroform	none	"
"	2	r.	l.	"	"	"	"	7	"	towards well side	partial on l.
"	3	l.	r.	"	"	"	"	4	"	none	no
"	4	l.	r.	"	"	"	"	10 hours	morphine	"	"
"	5	l. r.	r. l.	"	"	"	partial	35 days	exhaustion	after suppuration	"
"	6	l.	r.	partial	"	"	no	8	convulsions	none	"
"	7	r.	l.	total	"	"	partial	122	chloroform	"	"
"	8	r.	l.	"	"	"	no	4	"	"	"
"	9	l.	r.	"	"	"	——	still alive	——	"	"
Monkey.	1	l. r.	——	double hemianopsia	"	"	partial	231	phthisis	"	complete on r.
"	2	l-gyrus. r.	——	r. hemianopsia.	r. fore leg	"	"	still alive	——	"	"

It will be noticed that none of the animals died from shock, excepting a kitten one month old, which lived twenty-four hours. There was collapse due to hemorrhage, in two or three cases, but the animals survived. In general, monkeys bear the operation best of all, and dogs bear it better than cats. The operation is far easier on monkeys than on either cats or dogs, and much easier on cats than on dogs, owing to the relative amount of muscle and thickness of bone encountered. In dogs it is often best to completely excise a large piece of muscle to get it out of the way. It will also be noted that in a small proportion of animals there was slight suppuration in the wound. In the case of dogs this was always due to their loosening an edge of the dressing. In no case did it give rise to any additional cerebral symptom, or extend to the brain. It seems impossible for it to have affected in any way the results of the operations as far as vision was concerned, for these results were identical, whether suppuration occurred or not, and the number of cases in which it did not occur, are sufficient of themselves to demonstrate the area of the visual centre.

Conclusions.

1. Lesions of a sufficient size and depth in the posterior part of the occipital region in cats and dogs, invariably produce total blindness of the opposite eye, with no impairment of vision upon the operated side.

2. Hence it follows, that in cats and dogs, there is complete physiological decussation of the optic nerves at the chiasma.

3. The blindness is permanent, if between 2.5 and 3 cc. of brain tissue are removed in cats, and between 4.5 and 6 cc., in dogs.

4. To have the blindness permanent, the incision must be at least .5 cm. deep and 2 cm. in diameter, in cats, and 1 cm. deep and 3 cm. in diameter, in dogs, and it must involve at least two convolutions.

5. Smaller lesions produce complete blindness of the

opposite eye, lasting from a day or two, to six weeks. Lesion of a single convolution will do this.

6. The rapidity of recovery is directly proportional to the extent of the lesion.

7. The experiments performed upon only two monkeys, might not alone be considered sufficiently conclusive as regards monkeys, but they are endorsed in every detail by experiments previously made by Prof. Schäfer and Dr. Brown,* therefore lesions of the angular gyrus in monkeys produce no effect upon vision at all.

8. Removal of the entire occipital lobe, posterior to the angular gyrus in the monkey, produces permanent homonymous hemianopsia. The quantity of brain removed is between 4 and 5 g.

9. In monkeys, as in man, there is incomplete decussation of the optic nerves at the chiasma.

10. Hemi-anæsthesia in cats and dogs, results from extensive lesions in the posterior part of the occipital lobes. It is transient, lasting from three or four days to two months. It is not produced unless the lesions are at least 1 cm. cube in extent.

11. Hemi-anæsthesia in the monkey, results from removal of the angular gyrus, and from extensive removal of the occipital lobe, (injuring slightly the angular gyrus). It is transient, but may last for two months.

12. In cats and dogs, lesion of the occipital region results in rotatory movements, which are uniformly made towards the sound side. They are transient, but may last for two or three days. (We have noticed the same rotation from a great variety of other cerebral injuries.)

13. Lesion of the occipital region produces no loss of memory, other than the visual memory, and no disturbance of smell, hearing, or taste.

14. Occasional spastic contraction of the fore-legs, and occasional paresis, were observed during the experiments.

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* Loc. cit.

This was transient and incomplete, and the apparent paresis may have been the result of anæsthesia, and of difference in the pressure sense on the two sides.

15. The visual centre in the animals experimented upon, occupies a considerable area. Injury of a single occipital convolution (either 1st or 2d), will produce complete temporary blindness of the opposite eye, but nearly the entire occipital region must be removed or injured, to produce permanent blindness of the eye.

16. It is possible that a circumscribed focus of greatest intensity of vision, exists in one or other convolution, but our experiments thus far demonstrate that this is not the case, for a lesion of a single occipital gyrus produces the same degree of temporary blindness, whether it be in the 1st, 2d, or 3d convolution.

The value of experiments in cerebral localization is undoubted, but it is easy to draw erroneous conclusions. It is proved that it by no means follows, that because a definite lesion in a dog's brain produces a definite symptom, the same lesion in a monkey's brain will have the same effect, or that identical lesions in the brain of a man,* and of a monkey, produce identical symptoms. The convolutions are so different in the several cases, that it is difficult to trace the homology. The real use of such experiments upon the lower animals, is to establish the general laws of localization, that is, 1st, to prove that for animals of the same species, the same cerebral lesion invariably does produce the same effect; 2d, to establish the laws of recovery; 3d, to ascertain the exact boundaries of special centres for each species of animal, and find whether they are sharply limited, or diffuse and over-lapping.

* Hemianopsia in a man. Nothnagel, Seguin, Jour. Nervous and Mental Diseases, 1886. Henry Hun, Amer. Jour. Med. Sci., 1887.

It may be safely claimed that without experiments in localization upon the lower animals, and experiments made by removing their brain substance, we should have hesitated many years longer, before attempting the daring operations which have been performed upon the brain of man, in the past five years. Already seventy tumors have been removed from the cerebrum of man, with fifty recoveries, none of which could have been successfully diagnosed, without a knowledge of the principles of the doctrine of localization. Pathology justly claims its share in teaching us where to expect cerebral lesions, but physiological experiment upon the lower animals, far better demonstrates the chances of recovery, and the progress of lesions of varying size.

We beg to acknowledge our indebtedness to the following gentlemen: To Dr. W. S. Halsted of the Johns Hopkins Hospital, for suggestions in technique; to Dr. C. S. Bull, Professor of Ophthalmology in the N. Y. University Medical College, and to Drs. J. E. Weeks and J. B. McMahon for ophthalmoscopic examinations; and to Dr. John C. Cardwell of the Clark University, late Assistant in the Physiological Department of the Loomis Laboratory, for much valuable aid.

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ON THE POST-MORTEM IMBIBITION OF POISONS,

AND THE CHEMICO-LEGAL ASPECT OF EMBALMING.

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Although Orfila, as early as 1813, suggested the possibility that cases of imputed poisoning might occur, in which a distinction between ante-mortem and post-mortem arsenic (or other poison) would be of the first importance, it is only in recent years, and in this country, that the question has assumed grave practical interest.

In the first edition of his Traité des Poisons, Orfila raises the question by the following supposition: "Suppose an individual suddenly attacked by serious, spontaneous illness, who dies in a few hours, and into whose rectum some one injects, a few instants after death, a corrosive solution; the rumor that he has been poisoned spreads, and the magistrates appoint an expert to determine the fact; he opens the body, recognizes the presence of the poison by chemical analysis, and discovers more or less intense inflammation of the tissues upon which the poisonous substance has been applied; if he does not know that the poison might have been introduced after death, and if he is ignorant of the means to determine this fact, he asserts that the deceased has died by poison, and sacrifices an innocent victim to the vengeance of a vile assassin!"

In this edition Orfila states that such a case was recorded in the archives of the Criminal Court of Stockholm, but in a later edition he makes the correction that an inspection of the official documents failed to substantiate the fact, and that he had been the victim of a hoax.

Writers upon toxicology from Orfila to the present time have referred to the possibility of the perpetration of such a crime, in language more or less theatrical, but no instance

of its detection or even probability is, so far as I know, on record.

I can find but two instances in which such an hypothesis was set up as a defence: Kidd* cites a case, tried at Armagh in January, 1849, in which "the body presented appearances which caused a suspicion that a stomach pump had been introduced after death; and at the inquest a defence was attempted on the ground that the person had died from natural causes, and that poison had been maliciously injected into the stomach afterwards." What these "appearances" were he does not state. The defendants were convicted. Reese† mentions a case in a Western State in which "suspicions were exceeding strong that the poison had been thus designedly introduced after death for sinister purposes." These "suspicions" seem to have been based upon the following facts: 1st. The body was in a vault and therefore more readily accessible than if buried; 2d. There was a pecuniary motive which *might* have led a person, capable of such a crime by nature and information, to its commission; 3d. The body as a whole was well preserved, but the liver was "very much broken down," and, as arsenic has a great affinity for the liver, that organ should be particularly well preserved; 4th. No yellow sulphide was found, and as this is always formed by the generation of hydrogen sulphide during putrefaction, the arsenic found could not have been present during that decomposition, and must have been introduced into the body shortly before the analysis was made. Of these grounds for the suspicion the only one which has any scientific value is the last; and the force of that becomes very weak when it is remarked that the body had been buried "some three or four years," and when the solubility of arsenic trisulphide in alkaline liquids, also generated during putrefaction, is held in mind.

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* Dubl. Quart. J., 1850. X., 73.

† Trans. Coll. Phys., Phila., 1877, 3d Ser., III., 23.

All things considered, the probability of the occurrence of such a crime is most remote. But while it is extremely improbable that a toxicologist will be called upon to distinguish ante-mortem from post-mortem arsenic in a case of *designed* imputed poisoning, he is frequently brought to face the same question in cases of alleged embalming.

Dr. Geo. Hay, an analytical chemist, was the first, I believe, to draw attention to the possible dangers of the use of arsenic as an embalming agent.* He relates that a much vaunted embalming liquid, submitted to him for analysis, consisted of a solution of sodium arsenate containing three pounds five ounces to the imperial gallon; and that the directions were to inject a quart, or more, by the femoral artery. He further remarks: "Now it seems to me that while this system of embalming will most effectually arrest decomposition, it may be made the means also of effectually arresting the arm of justice. Suppose, for example, that a man wishes to poison his wife with arsenic, and that he has administered small and frequently repeated doses of the poison. The symptons might easily be mistaken for those of ordinary idiopathic gastritis; the woman dies, and the murdering husband has the body embalmed as above described; then, in these circumstances, the art of the toxicologist would be of no avail, for while it was a fact that the woman died from chronic arsenical poisoning, it was also a fact, that all the tissues had post-mortem been soaked in a solution of arsenic. Should it not be made a criminal offence to 'embalm' in this manner?" The case of Millard cited by Vaughan† would seem to be a fulfillment in all essential points of Hay's hypothetical case.

In recent years the use of arsenical "embalming" liquids has greatly increased. In a trade journal, published in the interest of "funeral directors," there are advertisements of nine liquids, each of which contains arsenic. In the case

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* Phil. Med. Times, July 31, 1876, VI., 576.

† J. Am. Med. Assoc., I., 115.

of the People *vs.* Ford, tried twice in Columbia County in 1888, the undertaker testified that, except in the coldest weather, his invariable practice was to inject the body as soon as possible after death.

If there be any method by which ante-mortem arsenic may be distinguished with certainty from "undertaker's arsenic," the use of the latter might be justified, but if there be none, the promiscuous squirting of arsenic into dead bodies, as now practiced, renders that poison the best adapted to the uses of the poisoner, if only he secure an accessory after the fact in a competent "funeral director."

The earlier experiments made with a view to the elucidation of this problem all pointed to the possibility of a distinction in two ways: 1st. By a comparison of the amount of arsenic* found in the superficial portion of the liver or other organ with that found in the interior, on the theoretical ground (substantiated in a measure by experimental evidence) that by post-mortem imbibition the poison soaks from without inwards, whereas it is carried by the living circulation to all parts of the organ; 2d. By the detection of arsenic in the brain, on the theoretical ground that, that organ being enclosed in a bony case, it is difficult to understand how it could be reached by post-mortem imbibition.

The first to furnish experimental evidence upon the subject was Orfila. From four experiments, one with a canine cadaver, one with a human cadaver, and two with human forearms, using solutions of copper salts, he formulates these conclusions:

"1st. That the salts of copper injected into the stomach or rectum of cooled cadavers of dogs or man penetrated by imbibition first into the organs nearest to that portion of the digestive canal into which they were introduced.

2d. That they afterwards travel either into the interior of those organs, or into other, more remote, viscera; but

* Throughout this paper I refer to arsenic as being the poison most commonly used, and also that which forms the chief ingredient of most embalming liquids. What is stated concerning it is also probably true of other poisons.

that their course is so slow that at the end of ten days, even when the stomach contains a large amount of cupric solution, the central and superior part of the liver, for example, and *a fortiori* the brain, the muscles of the legs, etc., do not contain an atom.

3d. That everything leads us to believe that they would never reach as far as the parts most distant from the point at which they were applied, at least in quantities sufficient to be detected, if the amount injected into the digestive canal was small.

4th. That it would be nevertheless possible that the passage of the poisonous liquids through the dead tissues might be very much slower, and that it would finally stop altogether at a certain distance from the digestive canal if these liquids were of such a nature, like the salts of copper, as to form with our organs a sparingly soluble or insoluble compound.

5th. That in any case such a decomposition would not occur immediately with the whole of the poisonous liquid, since, after ten, twelve and fifteen days, I could easily dissolve in cold water, and in a few hours, a part of the cupric salts which existed in the organs, and of which a part had reached there by imbibition."*

Two experiments were made with arsenic upon the cadavers of dogs. Into the rectum of each, four grammes of powdered arsenic trioxide were introduced, in one case five minutes after death, in the other twenty-five hours after. In both cases the body was examined twenty-four hours later, and there was a sharp line of demarcation of the reddened portion of the gut, which was not the case when the same poison was similarly introduced into the rectum of a living dog. To these experiments is added "Experiment IV. This experiment, repeated three times upon human cadavers, furnished analagous results." †

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* Traité des Poisons, 5th Ed., I., 56–60.

† L. c., I., 539–540.

Similar experiments with corrosive sublimate upon canine and human cadavers afforded similar results.*

I have quoted the experiments of Orfila thus at length because he has been frequently misquoted as believing in the rapid saturation of a cadaver by imbibition, by the citation *alone* of the following: "A wretch might, with intent to accuse an innocent man of having been the author of a poisoning, introduce a poisonous solution into the digestive canal of a cadaver, which would then penetrate by imbibition to the most distant organs, from which it would be extracted by the experts, who would be led to believe in poisoning." †

In 1850, J. H. Kidd, in connection with the Armagh case above cited, made two experiments—one with a cat, the other with a rabbit; the injection being made into the stomach twenty-four hours after death, and the viscera examined thirty and twenty-three days later respectively. In the first experiment arsenic was found in the mesentery, the psoas muscle and the liver; in the second, in the liver, kidney, heart, fore legs and muscles of the back, but none in the brain. A ligature had been tightly tied about the neck.

Other than the observations of Kidd, we have no experimental evidence upon the subject until the attention of Reese was drawn to it by the letter of Hay above quoted. Christison, Paris and Fonblanque, Taylor, Devergie and Casper refer to it incidentally. Van Hasselt,‡ Buchner,§ and Seidel‖ suggest that arsenic may find its way into the human body, before or after death, by its administration as a medicine, by medicines contaminated with arsenic, by arsenical mineral waters, by the flesh or milk of animals treated with arsenic, from the presence of arsenic in fertil-

* L. c., I., 730–732.
† L. c., I., 61.
‡ Allg. Giftlehre., 1862, II., 250.
§ Ger. Med., 1872, 378.
‖ Maschka. Handb. d. Ger. Med., 1882, II., 250.

izers, by employment in the manufacture of arsenic or of shot, from the soil of cemeteries, and from the use of artificial flowers or fabrics colored with arsenical dyes in dressing the corpse. But they say nothing either of post-mortem imbibition or of embalming.

Reese* directed experiments by his students with arsenic, tartar emetic, and corrosive sublimate upon the cadavers of dogs, and quotes the results of Dr. Geo. MacCracken, showing the presence of these poisons in the spleen, liver, omentum, kidneys, and fundus of the bladder, after periods of burial of twenty-one, thirty-seven, forty-four and fifty-nine days. He sums up the question as follows: "Is it possible in an unknown case of poisoning, where the whole issue depends on the discovery of the poison in the tissues of the body, to distinguish between poison really absorbed during life and that which has been merely imbibed after death? * * * Can the distinction be positively made? My reply is this: If I had the opportunity to make a careful comparative analysis of the interior of the organ, the liver for example, with the same organ—especially if the examination were made not long after death—and I discovered the poison in the interior as well as the external part of the organ, I should be disposed to regard it as evidence of really absorbed poison. * * * But, on the other hand, if the poison were found on the exterior of the organs only, and not in their interior * * * I should regard it as a true case of post-mortem imbibition." Then, after referring to the experiments of Scolosuboff,† he says: "Should this prove the fact,‡ we shall be in possession of a positive and unequivocal chemical method of distinguishing between ante-mortem and post-mortem poisoning by arsenic (and probably by other metals), by the detection of the poison in the brain and spinal cord; since it is scarcely

* Trans. Coll. Phys., Phil., 1877, 3d Ser., III., 33.

† Arch. d. Phys., No. 5, 1875.

‡ That arsenic is deposited in the brain and cord of man as it is in those of the lower animals.

conceivable that a poison, introduced into a body after death, could penetrate by imbibition within the cavity of the cranium or spinal column." *

Up to this time, therefore, all experimental evidence had gone to show that the detection of arsenic in the brain or in the interior of a large organ is proof positive of its absorption during life.

The next experimentors were Vaughan and Dawson,† who made two experiments, one upon a musk-rat, which is of little interest because of the small size of the animal; the second with a human cadaver, which is most important as being the first in which the proper subject was used since the days of Orfila, and with the perfected methods of the present time. Into this cadaver, two to three days after death, an unweighed amount of arsenic trioxide was injected by a bulb syringe by the mouth and rectum. After twenty-five days, the body, in a good state of preservation, except the brain, was opened, and the kidneys, liver, lung, heart, colon, rectum, spleen, stomach and brain subjected to quantitative analysis for arsenic. Affirmative results were obtained with each organ, including the brain; the greatest proportion being found in the rectum (7.5%), the least in the brain (.0003%; 1028 grams of brain tissue yielded .00363 $As_2 O_3$). This result, so far as the brain was concerned, was justly unexpected: "We were surprised at finding arsenic in the brain, and the query arises, by what avenue did the poison reach this organ? We noticed that while throwing the fluid into the mouth at one time, when the bulb of the syringe was very forcibly compressed, a portion of the fluid returned through the nose. It is probable that some of the arsenic adhered to the roof of the pharynx and along the nasal passages, and from thence penetrated the brain." Reference is also made to experi-

* Subsequently Reese modified his views in the light of the experiments of Miller and Vaughan. Med. Jurisp., 2d ed., 1888, 210.

† Journ. Am. Med. Assoc., I., 115.

ments of Prof. Kedzie upon cats in which he found arsenic in the liver, spleen, heart and kidneys *treated together*,* but nothing as to the brain.

Dr. G. B. Miller † made an experiment with a dog, buried for sixty days, in which arsenic was found to have imbibed from the stomach to the brain and other organs.

In the case of the People *vs.* Ford, the question under discussion was one of importance. The body had been treated by an undertaker, and had been subsequently buried fourteen days. The brain contained arsenic.

As no reliance is to be placed upon experiments with small animals, as the conditions in this case were different from those of Dr. Vaughan's experiment, and as I was still a firm believer in the brain theory of Prof. Reese, I concluded to experiment before the trial in as nearly as possible the same conditions as existed in the case under examination.

Experiment I.—Cadaver of negress; æt. 30. Died in hospital, no arsenic administered during last illness. Three days after death. A solution was made by heating together 198 grams arsenic trioxide, 212 grams disodic carbonate and 1000 cc. water. Of this solution 700 cc. were injected into the nares by very gentle pressure, the nostril being closed over the pipe during injection. Nearly all of the fluid injected escaped by the mouth. The head (which had been shaved), neck and breast were thoroughly washed, and the head separated from the trunk at the fourth cervical articulation. The head was preserved, in an upright position, in an earthen jar from March 17th to March 31st at a mean temperature of about 40° Fahr. On the latter date the skull was opened, the vertical position being maintained, and the brain was removed by hands and instruments which had not been in contact with other parts. There was no odor of putrefaction, and the brain tissue was

* The italics are mine.

† Am. Nat., 1886, xx. 101.

as firm as in a recent subject. Two sections of the brain were taken, each weighing about four ounces, one from the vertex, as far removed from the ethmoidal foramina as possible, the second from the base, immediately over those openings. Each part was separately treated for arsenic by the Fresenius and von Babo and modified Marsh methods.* The portion taken from the base yielded the mirror shown in *a*, fig. 1, the other the mirror shown in *b*, fig. 1.

FIG. 1.

Two facts are proved by this experiment.

1st. That arsenic injected in the manner described will reach the brain in fourteen days (and probably in a much shorter period).

2d. That little reliance is to be placed upon alleged possibility of determining between post-mortem and ante-mortem poison by its presence in the latter case in the *interior* of an organ. From the position of the head during this experiment, it is impossible that the arsenic found in the superior section of brain, could have reached there by another route than by imbibition through the substance of the organ, and consequently the interior must have contained as much, certainly, as the vertex. I regret that I did not also take a portion from the centre of the organ, but neglected doing so at the time because I had no expectation of finding arsenic in the superior section, if in the brain at all.

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* It is scarcely necessary to state that the purity of all chemicals used was beyond question.

At the first trial of the case the testimony of the undertaker showed that I had been misled as to the method of procedure used by him. I therefore made another experiment under the conditions described by the undertaker when under oath.

Experiment II.—Cadaver of male, æt. 42, three days after death. Died in hospital of erysipelas; had been previously in an insane asylum. Arsenic had not been administered. The body was placed upon a dissecting table, the head elevated by placing a brick under the occiput. A curved composition catheter, 6 inches in length, was passed through the nostrils and posterior nares into the pharynx, and four fluid ounces of a solution of commercial sodium arsenate (2 lbs. to the gallon) were slowly injected through each nostril. A considerable portion of the liquid injected escaped by the mouth, but none by the nostrils, although the latter were not compressed, and the diameter of the catheter did not fill the canal. The catheter was then withdrawn from the nostril, and passed through the mouth into the œsophagus 6 inches from the lips, and one pint of the same liquid injected slowly. None escaped by either mouth or nostrils. The body was allowed to remain undisturbed upon the table, in a current of air between two windows, from May 12th to May 26th, the weather alternating from cool to very warm. On the 26th, putrefaction was far advanced, the odor was intense, the abdomen distended with gas to twice its former size, the surface green and brown. The skull was opened, and the brain, pultaceous and semi-liquid, was removed by an assistant whose hands had not been in contact with the cadaver. About four ounces of the brain, treated by the same method as in Experiment I. yielded the mirror (fig. 2), with the introduc-

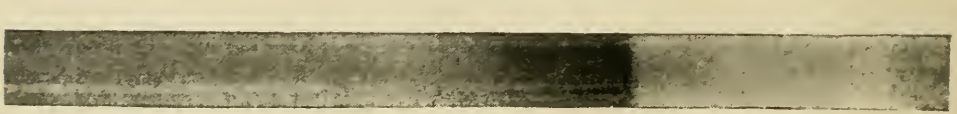


Fig. 2.

tion of about one-third of the final sulphuric acid solution into the Marsh apparatus.

The results of the last experiment were entirely different from what I expected, and I still believed that the arsenic found in the brain had penetrated to that organ from that portion which had reached the buccal cavity by the injection through the nostrils. I therefore made a third experiment in which the injection was limited to the stomach and abdominal cavity.

Experiment III.—Cadaver of male, æt. 44, died in hospital of phthisis. No administration of arsenic. Died Nov. 19th, 1888. Nov. 23d, a well vaselined œsophageal catheter was passed through the mouth into the stomach; one and a half pints of a solution of commercial sodium arsenate (2 lbs. to the gallon) were injected into the stomach, followed by a small amount of water, as the catheter was withdrawn, to prevent mechanical transportation of the arsenical liquid upwards. None of the injected liquid regurgitated. The body had been previously placed in the same position as that in Experiment II. A number nine catheter with stopcock attached was passed into the bladder, and the penis ligated over it. The bladder was filled with distilled water, and the stopcock closed. A 6-inch steel trocar was passed through the abdominal wall, a little to the right of and below the umbilicus, and inserted to its full length upwards and a little to the right. The body was left undisturbed in a dry vault till Dec. 7th. At that date putrefaction was far advanced, the abdomen very much distended, the face bloated, the surface almost black, and the odor almost intolerable. The brain, which was pulpy in consistency, was removed as in the former experiments. By opening the stopcock attached to the catheter in the bladder, and applying gentle pressure to the abdomen, three and a half fluid ounces of a dark, bloody liquid were obtained from the bladder. A piece of muscular tissue was taken from the calf of the right leg. Two-thirds of the tibia were

also removed. Each part was placed in a separate vessel, and separately examined for arsenic by the usual method. A portion of the brain tissue, weighing 297 grams, yielded the arsenical mirror *a*, fig. 3. One-half of the liquid from the bladder gave the mirror *b*, fig. 3. From 200 grams of the muscular tissue from the leg the deposit *c*, fig. 3, was obtained.

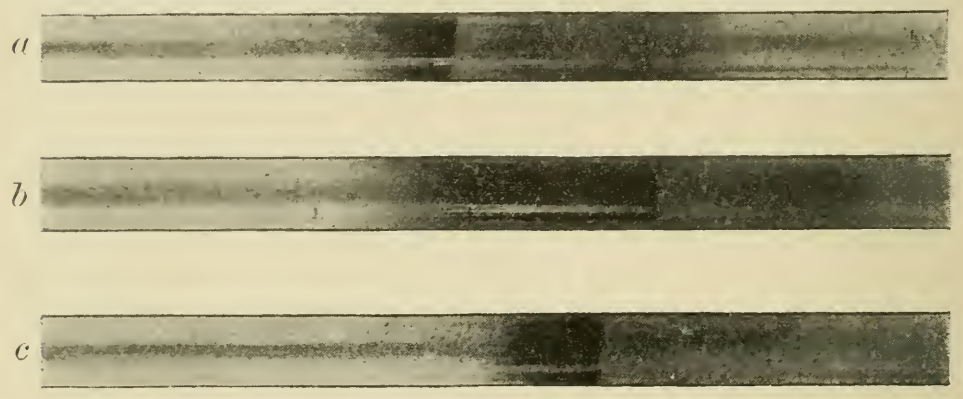


Fig. 3.

The tibia was not examined. A blank testing with a piece of beef and the same chemicals used in the above experiments, left the tube perfectly clean after a heating of three hours.

An arsenical solution, therefore, if injected into a human cadaver three or four days after death, in such a manner that the direct introduction is limited to the abdominal cavity, will, in fourteen days, penetrate to every portion of the body.

I have wished to make a further experiment, more nearly in accordance with the usual practice of undertakers in the point of time of introduction, injecting the arsenical solution one, two or three hours after death, but have been as yet unable to fulfill the conditions. It seems highly probable that the rapidity of imbibition is greater during the period immediately following death than it is later, and that arsenic injected soon after death would be found in

the brain and lower extremities in a much shorter time than fourteen days. Indeed, even under the conditions of experiment III., it is probable that a period of less than two weeks may suffice for the transportation of arsenic to the brain and lower extremities.

It is possible also that it may become doubtful under certain conditions whether arsenic found by analysis in an uninjected (not "embalmed") body is of ante-mortem or post-mortem origin.

In 1839, Orfila noted the fact that the soil of cemeteries frequently contains arsenic as a normal constituent, and considered the possibility of "cemetery arsenic" becoming the source of mistaken accusations of poisoning. He demonstrated, however, that when arsenic is present as a natural constituent of a soil, it is always in a form of combination insoluble in water, usually as more or less arsenical pyrites.

Many observations by many observers have shown that a body buried, even for a period of years, in a cemetery whose soil is naturally arsenical will not take up arsenic from the soil so long as the parts of the body remain mechanically separable from the surrounding earth. But at present we have to deal with "cemetery arsenic" in a soluble form, as well as with the insoluble.

In the Ford case, already cited, the body was exhumed a second time in April, after a burial of six months. The grave, which was upon a hillside, near the top, filled rapidly with water to within three feet of the surface, and the casket and its contents were saturated with water. The linen on the cadaver, the stockings, and the lining of the casket, originally white, were marked with yellow stains of arsenic trisulphide. From a portion of the stocking a trace of arsenic in a form soluble in water was obtained, and the linen lining and earth surrounding the casket contained notable amounts of arsenic, in a form of combination insoluble in water.

The arsenic in this case had been injected in the form of

arsenate of sodium, free from arsenite, and therefore the formation of the yellow sulphide must have been preceded by the reduction of the arsenate to arsenite, during which process the arsenic remained in the soluble form. How far during this interval of six months did this soluble arsenic pass by infiltration through the soil of the cemetery, and to what extent was it deposited in an insoluble, and therefore retainable form, in bodies buried in neighboring graves?

A FEW VIVISECTION EXPERIMENTS,

Made with a view to demonstrating the mechanism by which a collapsed lung is re-inflated, while its surface is freely exposed to the pressure of the atmosphere, through an opening in the pleural cavity.

J. O. Dwyer, M.D.

Through the kindness of Prof. W. Gilman Thompson, I was enabled to initiate some experiments at the Loomis Laboratory, for the purpose of throwing some light on the apparent physical paradox involved in this process.

Physiologists who have expressed an opinion on this question, maintain that the lung under these circumstances cannot re-expand.

* Foster, for example, speaks as follows: "When the pleura is punctured, and air can gain free admittance to the pleural chamber, the effect of the respiratory movements is simply to drive air in and out of that chamber, instead of in and out of the lungs. There is consequently no renewal of the air within the lungs under these circumstances."

Clinicians, on the contrary, know that in every case of empyema in which the chest is freely opened for the purpose of drainage, complete re-expansion of the lung takes place unless the organ be permanently injured by too long a continuance of the compression.

It would be absurd to suppose that the pressure of the atmosphere operating through the air-passages during the act of inspiration, can exert any dilating influence on the collapsed organ, because the same pressure is applied to its surface, and there are, in addition, the elasticity of the lung, and other impediments to re-inflation, to be overcome. The re-expansion of the lung, under these circumstances, must therefore be accomplished by some force generated by the

* Foster's Text Book of Physiology, page 331.

expiratory movements. That this force is compressed air driven from the sound into the contracted lung during forcible expiration, I was fully convinced before beginning these experiments (see paper in Archives of Paediatrics for November, 1889).

The sound lung being distended by a full inspiration, followed by spasmodic contraction of the expiratory muscles, which condenses the air, and its rapid escape being prevented by partial closure of the glottis, a portion of it is pumped into the contracted lung. If these forcible expiratory movements be repeated in quick succession, the collapsed lung is not only expanded until it fills its cavity, but a portion may even be driven through the opening in the chest wall.

The first dog died under ether, before the chest was opened, and the cause of death was undoubtedly asphyxia from paralysis of the glottis openers. The tongue was drawn well out of the mouth, and notwithstanding the fact that the animal made forcible efforts to inspire, no air entered. On inserting the finger, the epiglottis was found firmly closed over the larynx, but raising this, gave no relief.

The second dog almost succumbed from the same cause, viz., obstructed inspiration due to the paralyzing effect of the ether on the abductor muscles of the cords.

Drawing the tongue well out of the mouth did not raise the epiglottis, nor did raising it by the finger, allow any air to enter. He was finally resuscitated, and an opening was made in the middle of the right chest, in which a canula three-fourths of an inch in diameter, and one and a half inch in length, was placed.

As the animal was recovering from the ether, several spasmodic expiratory movements were made in quick succession, which expanded the lung, and forced a portion of it into and through the canula, fully demonstrating the theory advanced in the paper already referred to. This occurred several times, and, on one occasion, the protruding

portion of lung extended fully half an inch beyond the external opening of the canula, but immediately receded with the re-establishment of normal respiration. The canula was left in position for twelve days, when the dog was killed. The lung was found in a state of almost complete atelectasis, and consequently very much reduced in volume, yet it was adherent at all points down to the opening in the chest. How a collapsed lung could thus contract adhesions, would be difficult to explain, were it not for the fact that, several times, owing to urgent dyspnœa, it was found necessary to place a cork in the canula. This excluded the air, and allowed the lung to become sufficiently re-expanded to bring the opposing surfaces of the pleura in contact, and retain them in that position long enough for the adhesions to form. Little value therefore attaches to this part of the experiment.

The next experiment attempted, was to fill one pleural cavity with any indifferent fluid, in order to compress the lung and reduce it to the same condition which exists in an extensive empyema ; then to destroy the power of compressing the air in the sound lung during forcible expiration, and consequently the power of pumping it into the contracted organ, by giving a free outlet for the escape of the air. This could be accomplished in a great measure by severing the trachea below the larynx, detaching the former at all points above, turning it out and uniting the skin behind it, thus cutting off the constricted glottis, and giving the full calibre of the trachea for the rapid escape of the air when compressed by the expiratory muscles. It was the intention, as soon as this operation was completed, to open the pleural cavity, and allow the fluid to escape and air to enter freely, as in the treatment of a case of empyema. This attempt proved abortive, owing to the previous condition of the dog's mediastinum, as demonstrated in the following experiment.

A medium sized animal was selected, and when fairly under ether, an intubation tube was placed in the larynx, to

avoid the accident previously described, which it did very effectually. The right pleural cavity was then opened, and a quart of warm milk slowly injected. Urgent dyspnœa came on before all the milk had entered, which almost proved fatal. The animal recovered slowly from the ether, still laboring for breath, and this continued with greater or less severity until death, eighteen hours after the operation.

At the autopsy, the milk was found about equally distributed in both pleural cavities, having percolated freely through the mediastinum. Both lungs were very much collapsed, and contained but a small amount of air.

Any further experiments in this line would, of course, be useless as far at least as the dog is concerned. An important practical point, suggested by these few experiments, is the manner in which ether proves fatal in this animal. It is quite possible that it acts in a similar manner in the human subject, and if so, it teaches the necessity of having a proper laryngeal tube ready for insertion, on the first appearance of asphyxial symptoms. The most precious moment is lost in first attempting artificial respiration, and subsequently opening the trachea, the necessity for either of which would be obviated by promptly placing a tube in the larynx. If the paralyzed cords drop together at the beginning of inspiration, which is the more probable time, the partial vacuum in the chest remains, and the greater the efforts to draw air into the lungs, the more firmly they are pressed towards the median line. Should the epiglottis also be drawn down, as occurred in two of these experiments, the pressure of the atmosphere holds it in that position, and still more effectually excludes the air.

THE EFFECT OF OPENING THE PLEURAL CAVITY.*

By W. P. Northrup, M.D.

Experiments made upon healthy dogs to determine whether there is sufficient cohesion between the two pleural surfaces to maintain them in apposition, the costal pleura having been opened.

These investigations were made to test the validity of statements made by Samuel West, F.R.C.P., London, in his "Bradshawe Lecture" published in the Brit. Med. Journ., Aug. 20th, 1887. The following is quoted from that paper: "The fact, therefore, that the pleural cavity may be laid open, and that yet collapse of the lung with consequent pneumothorax may not occur, must be accepted, and an explanation sought." Again: "When the lung does not contract after the pleura is opened, it must be kept on the stretch by some force greater than seven mm. of mercury, (the force of normal elasticity of the lungs—Donders and Hutchinson), and there seems to be no place for such force to exist, unless it be in the pleura itself, and if here, it is probably to be found in the *cohesion* between the two serous surfaces." Then follow elaborate experiments with discs of wood, upon which are stretched stomachs and other membranes, the cohesion of which when wetted and applied, the one to the other, shall demonstrate that a lung will not let go its hold upon the parietal pleura, except under force directly applied.

The writer continues: "The result of these observations is to prove that there is some force other than atmospheric pressure by which those two smooth surfaces are held together; and without using the term in too technical a sense, I may speak of it as cohesion." Again: "Pneumo-

*See paper in the Proceedings of the American Paediatric Society Archives of Paediatrics, Vol. 6, p. 786.

thorax can therefore no longer be regarded as a condition to which there is an inherent tendency in the healthy body, but, on the contrary, as a condition brought about by the forcible separation of the pleural surfaces, and in this respect exactly analogous to the distension of the subcutaneous tissue which occurs in surgical emphysema. . . It would seem to follow as a corollary, that the force required to distend the subcutaneous tissue, must be less than that required to separate the layers of the pleura. . . . Surgical emphysema. . . may in reality be a protection against it (pneumothorax), the air making its way in the direction of least resistance beneath the skin, rather than between the pleural surfaces." "It is evident, further, that where the pleura is laid freely open, so that the air passes away without hindrance on expiration, the liability to pneumothorax will be still further reduced."

The following experiments were made to add to the discussion of a paper on the expansion of the lung after empyema, the chest wall remaining open.

(1) Provided the lung becomes expanded till the pleural leaves are in co-aptation, will they maintain themselves there?

(2) What is the force which expands the lung?

It seemed to me that discs of wood and membranes, could not prove arguments worthy of consideration in cases of pleuræ; I therefore set about testing the conclusions of Samuel West by experiments upon dogs.

I desire to express my indebtedness to the facilities of the Loomis Laboratory, and to the valuable assistance rendered by the Director of the Physiological Department. Prof. W. Gilman Thompson, and his Assistant, Dr. Cardwell.

Experiment I.—A street cur, weighing about twenty-five lbs., etherized. Having trimmed away the hair, a free incision was made parallel with the sixth and seventh ribs,

reaching down to the intercostal muscles, at a point mid-way between their angles and their sternal cartilages. The intercostals were cut upon a grooved director, till no tissue overlay the lung at the bottom of the incision, except the parietal pleura. Through it could be seen the fully-expanded lung, gliding back and forth in rhythmic respiration. The pleura was then lifted on a fine-pointed forceps, and a pin-hole opening made in the parietal pleura, without injury to the visceral layer, and without allowing any force to crowd the lung away from the ribs or separate the two serous leaves. Even with a pin-hole opening, there was an instantaneous recession of the lung; on the next expiration, a fine thread of air was expelled, and at the second respiration, the lung was not to be seen at all. A probe passed two and one-half inches straight in, before it reached the lung.

Experiments II, III, IV, and V, were followed by exactly the same results in every particular, and were performed on dogs of various sizes and conditions of nutrition, but all healthy. According to Mr. Samuel West's experiments, reported by himself, we should expect the force of cohesion to keep the pleural surfaces gliding upon each other, on all margins of the fenestra. Discs of wood covered with stomach and diverse membranes, according to West, cohered with a force equal to, and more than, seven millimeters of mercury, the estimated elasticity of the normal lung.

Second Series of Experiments.—Made to ascertain the behavior of the lungs when one and then both pleuræ have been opened. A strong, well-nourished dog, of about twenty pounds weight, was etherized, and a double-flanged canula, the diameter of the hollow cylinder being half an inch, was inserted (buttoned in), between the sixth and seventh ribs, about mid-way between their angles, and the costal cartilages. Dyspnœa became marked immediately on entrance of air to the pleural cavity, the animal, of

course, lying upon the more useful lung. The operation being completed, and the lips of the wound stitched about the canula, a close fitting cork was inserted into the canula, at the end of expiration. Immediately the breathing became slower and less labored, and finally the animal seemed to be suffering no embarrassment whatever from the opening.

The same operation was then performed on the other pleura of the same dog; a canula of three-quarters of an inch diameter being inserted, and tightly corked, at the moment of finished expiration. The dog was placed on the floor, and allowed to come out of ether. He was shortly on his feet; trotted back to his old corner; breathed to all appearances like any dog that had recently taken ether, and had suffered no further interference. When led, he trotted about, wagged his tail, and seemed comfortable. When fully recovered, and standing in the middle of the laboratory, one cork was withdrawn without any immediate effect. When led away from the operation-table, he trotted cheerfully, wagging his tail; when headed toward the table and ether, he struggled with vigor. These exercises caused some dyspnœa, but not much. The half-inch canula was the one open at this time.

After a little rest, with both corks in, and standing in the same place, both corks were simultaneously removed, and the dog was left to himself; he stood for a moment dazed, panting moderately, answered a chirping call, wagged his tail, and trotted off into the next room, among the monkeys and guinea-pigs. From there he was brought back and tied to a table-leg. This was about two minutes from the removal of both corks. Now began his severe dyspnœa, and it seemed to overwhelm him rather suddenly. He wavered to and fro; his eyes, tongue and lips became dusky; and with feet braced wide apart, he wavered and settled slowly to the floor. Here he lay flat on his belly, panting. Both corks were now replaced as before, catching the moment of finished expiration, in order to leave as little air as possible in the pleural cavity. In a few

moments, he was again as well as ever. With one cork out, the dog had suffered no dyspnœa when quiet, and out of ether, and on his feet. With both out, he succumbed in two minutes to urgent dyspnœa with deep cyanosis. I may add, that the result of this experiment is quite in accord with the experience of Dr. Thompson on former occasions.

Third Series.—A small street cur, poorly nourished, weighing about ten pounds, having served for another experiment, was subjected to further operation, being still under ether. A large opening was made in his thoracic wall, practically obliterating the wall. Dyspnœa and shock were severe, and the animal seemed about to succumb. Just at the instant of a severe spasmodic expiratory effort, a piece of plain glass was clapped upon the wet tissues of the thoracic wall, completing temporarily its continuity and enabling the animal, after some assistance, to resume respiration, and the observers were edified to see the lung gradually expand, become rose-colored, and nearly fill the cavity—which it would probably do in a moment more. Just then the dog, which was a poor subject, ceased breathing altogether and died.

Acting on the suggestion just received, we made haste to etherize a strong, well-nourished dog of twenty-five pounds, selected a site of operation, and proceeded to make a window in his chest. Provided with a circular glass, we made a cut in the skin just sufficient to let the glass pass like a button through a button-hole, cut down upon the sixth and seventh ribs in the usual location, stripped off their periosteum, and cut out two inches of the bones; gathered the pleura containing the vessels, belonging to the two ribs, within two ligatures, at the proximal edge of the wound, and snipped away the pleural membrane, leaving a nearly bloodless wound, with a fenestra two by two inches. The dog being allowed to come out of the ether a little, gave a spasmodic expiratory impulse, the glass disc was buttoned quickly through the slit in the skin, and instantly

respiration improved. A single stitch rendered it assured that the window would not slip away, and the dog was allowed to get rid of more of his ether. The glass window acted like a valve. At each respiration a few bubbles escaped at the margin, but no air entered. Finally the lung was fully expanded, and gliding rhythmically back and forth upon the glass, as upon the pleura-covered wall. At this point the dog evinced great activity, got up on the floor, and walked about, wagged his tail, and went to his old corner. He was quickly secured, and to save suffering, was etherized to death.

FURTHER OBSERVATIONS UPON THE PLEURAL CAVITY.

W. Gilman Thompson, M.D.,

Professor of Physiology.

The third series of experiments presented in the foregoing pages, by Dr. W. P. Northrup, are very instructive in showing the rapidity with which the lung expands again after air is allowed to enter the pleural cavity, provided the expansion is assisted by any sort of valve action, like the glass window described. The diaphragm is pushed up with great force in this case by violent expiratory efforts, and in rising, it tends to expel the air which has been admitted through the thoracic opening. If any valve can be made to close this opening, at the end of a deep expiration, the lung at once expands with the next inspiration. These experiments of Dr. Northrup's, confirm in every respect similar ones made with glass windows eighteen months ago, by Prof. A. M. Phelps, M.D., and myself in the Loomis Laboratory. More recently, I have inserted the finger through a small opening in the thorax, and used it as a valve to stop the aperture at will. Then through another small opening the tube of an Allan Surgical Pump was inserted, through which air could be withdrawn from, or driven into, the pleural cavity, while the effect upon expansion and contraction of the lung was readily estimated by the finger.

Since Dr. Northrup's interesting experiments were performed, I have made an improved glass window which has been sewed into the thorax of a dog, and worn by him for over two months. No antisepsis was used, and empyema resulted. Through the window, I was able to watch, from day to day, the increase in the amount of pus, the change in the level of the fluid on altering the dog's position, and the forma-

tion of adhesions. The dog is still alive and active, having worn his window for two months.

This forms an admirable method of studying pathological changes like those of artificially induced pneumonia, etc. The window is very simple. An oval piece of window-glass is cut with a diameter of 2½ by 2 inches. The edges are ground smooth. The two longer edges of the oval are bent inward and then outward again so as to form two grooved sides. This bending reduces the transverse diameter of the window to about one inch. A segment of one rib is excised, the arteries are pushed aside, and the window is inserted so as to replace the excised rib, its two grooved edges fitting around the contiguous ribs above and below, and thus holding the window in place. The margins of the wound are then tightly closed, excepting just over the centre of the oval window, and in healing, they prevent any leakage of air.

THE QUESTION—DOES PROLONGED FIXATION OF JOINTS PRODUCE ANCHYLOSIS?

A. M. Phelps, M.D.

Professor of Orthopædic Surgery in the Medical Department of the University of the City of New York.

It is generally accepted by the profession, and taught by the majority of our leading surgeons :

1st. That if a normal joint is fixed immovably for a certain length of time, anchylosis will certainly result.

2d. That motion is absolutely necessary to prevent this calamity, and to preserve the normal integrity of the joint.

3d. That it is also necessary to move an *inflamed joint* to prevent anchylosis.

Our text-books on surgery, and its various departments, are filled with notes of warning against allowing prolonged immobilization in the treatment of fractures, or of inflamed joints, (in cases where immobilizing appliances are used), lest anchylosis result.

Not only the inflamed joints are to be moved, but all joints which have been fixed by the dressing.

For the purpose of determining, so far as we might be able, the accuracy of these propositions, a series of experiments were conducted in the Loomis Laboratory last winter upon four dogs. I will remark that, prior to two years ago, I accepted the foregoing propositions as truths. But observations in the treatment of joint diseases since that time, led me to doubt, and the result of the following experiments, together with further observations in the treatment of inflamed joints, confirms my belief that they are entirely erroneous.

Through the courtesy of Prof. W. Gilman Thompson, who kindly extended to me the use of the laboratory, and who, with his obliging assistant, Dr. John C. Cardwell, rendered me valuable assistance, we were enabled to carry the work through to a satisfactory conclusion.

The difficulty of keeping the limbs of animals lashed in one position for a long period, together with the possibilities of disease and excoriations, will, I think, be apparent to all.

Dogs are quite liable to contract mange, and infect the other animals, necessitating their immediate removal. And then they do not bear confinement well in a cramped, unnatural position. However, with all of these difficulties to overcome, we succeeded in keeping one dog six weeks, one dog three and one-half months, and two for five months, lacking one week.

The first dog, killed at the end of six weeks, was less than one year old. He had been dressed in the following manner: Under ether, the hind leg was carefully enveloped with cotton batting. Over this was applied a roller and a plaster of Paris bandage, the leg being held in a straight position, until the plaster became hard. The body of the dog was now similarly dressed with the cotton batting, and roller. A few turns of the plaster of Paris bandage around the body, finally including the leg, which was drawn well up over the back of the dog, completed the work of immobilizing. See Fig. A.

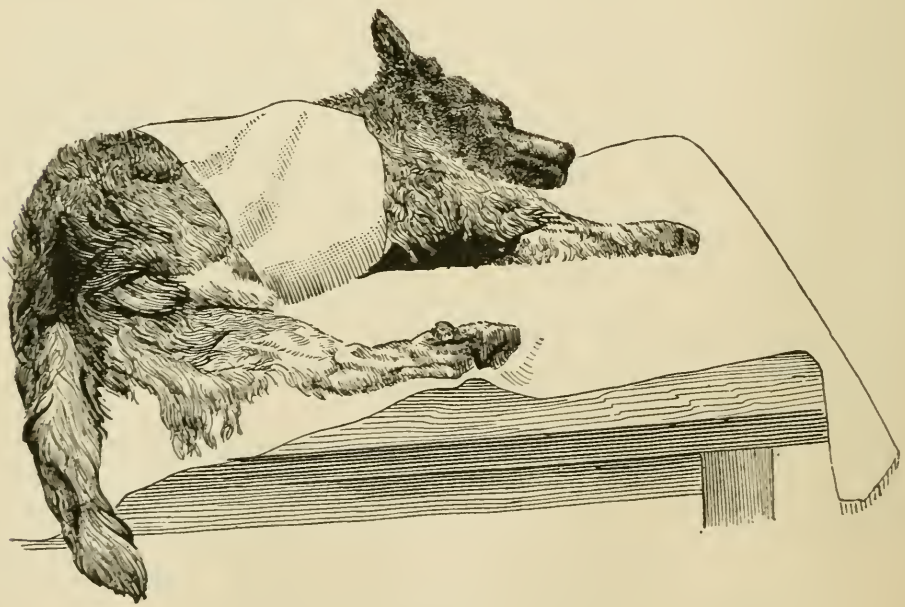


Fig. A.

This secured the hind leg to the plaster cast, which was closely fitted to the body, making dog, cast and leg one piece, as it were.

The leg being drawn up over the back in this intentionally cramped position, induced considerable intra-articular pressure at the hip joint by putting the muscles and ligaments upon the stretch, the leg being used as a lever.

The dog did very well for a few weeks, there being but slight rise of temperature. But at the end of the fifth week he refused to eat, and began to emaciate. A week later, on the 42d day, he was killed. An excoriation, due to pressure, was found below the knee upon removing the dressings. This accounted for the loss of appetite, as much pain must have been induced.

The ankle and knee joints were normal in every respect.

Upon opening the hip joint, however, the normal amount of synovial fluid escaping, a dark, congested spot was found on the head of the bone, which corresponded to a similar one in the acetabulum, marking the points, of contact between the head and the socket. There was also a dusky appearance of the entire head of the bone, and the ligamentum teres, closely resembling the congestive stage of inflammation.

The synovial membrane was normal. See Fig. B.

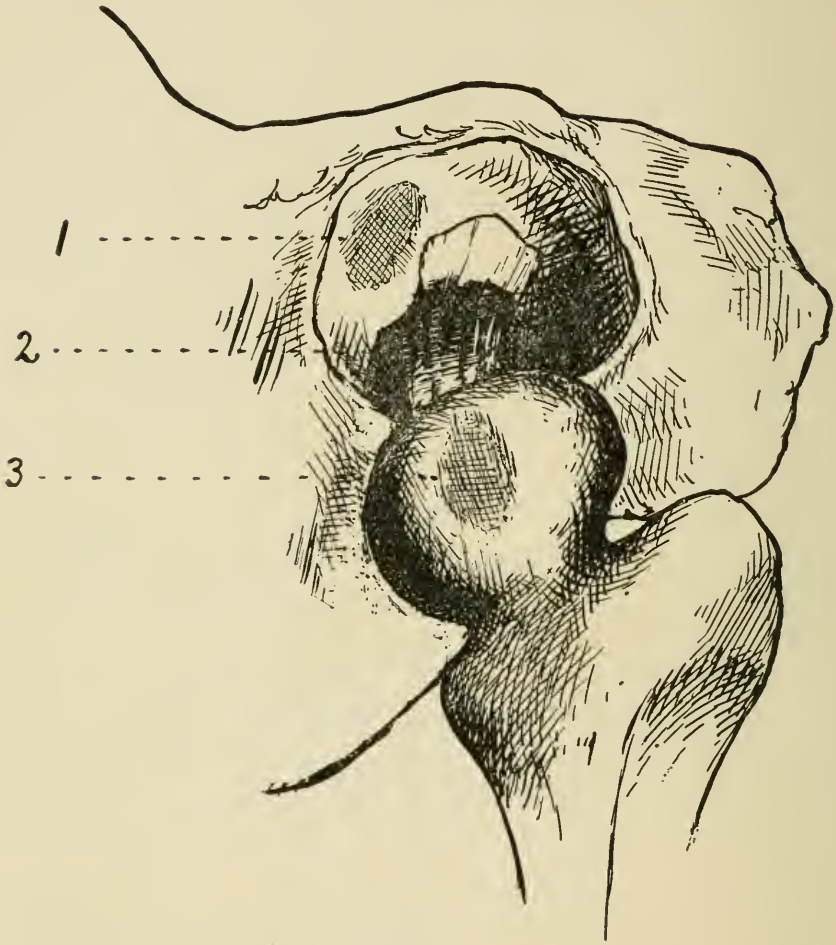
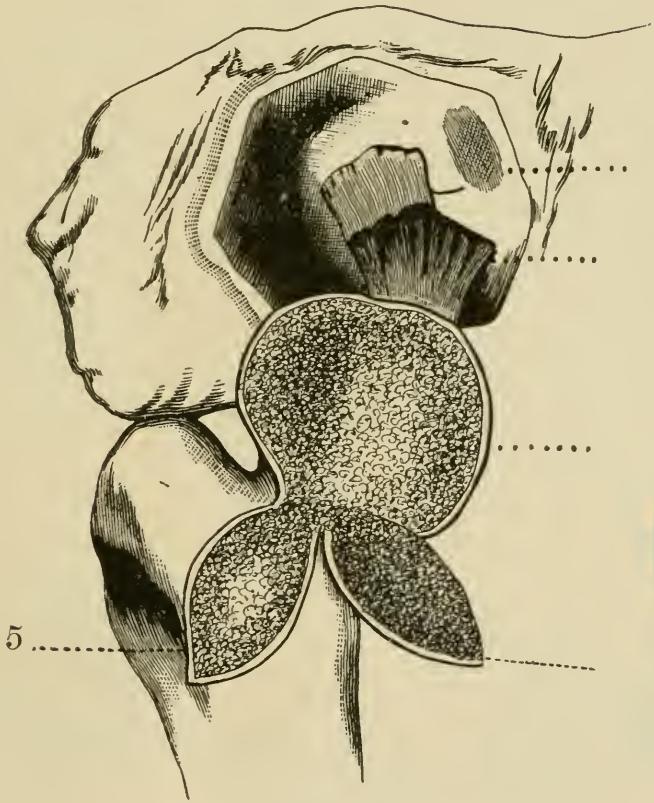


Fig. B.

1. Congested spot in acetabulum.
2. Ligamentum teres.
3. Congested spot on head of bone which rested against 1.

A section was made of the head of the femur, and another which divided one of the halves again into two equal parts, the cut passing through the congested spot (Fig. C, 5–5).

See Fig. C, which was drawn on a block, (reversed by mistake) and photographed.



BIOLOGICAL LABORA

FIG. C

Immediately underneath the cartilage and extending to a considerable depth into the head of the bone, the cancellated structure was deeply congested, (4) due to the meshes of the bone being filled with coagulated blood. The centre of the head, however, was of a lighter color, and to the eye, it appeared normal.

This light streak in the centre of the bone grew lighter and wider, as it extended towards the ligamentum teres, which was due probably to a more perfect circulation of blood and better nutrition than exists in the more peripheral portions. (6) is the congested spot in the acetabulum. Dr. J. H. Linsley made a section of the bone for microscopical examination. But during the decalcifying process, which was

necessary before sections could be made, the coagulated blood was washed out of the interstices, and the specimens presented nearly the normal appearance microscopically.

I neglected to state that the muscles of the leg were considerably atrophied.

The other three dogs were treated similarly to the first, only the fore-leg was substituted for the hind-leg. The fore-leg is easily secured to the body immovably with plaster of Paris, and the dressings are not so likely to become filthy, as when the hind-leg is used. To prevent the dogs from gnawing the dressings away, which they would surely do if allowed, the plaster of Paris bandage was carried forward onto the neck, making a stiff collar, which kept the heads always to the front.

See Fig. D.

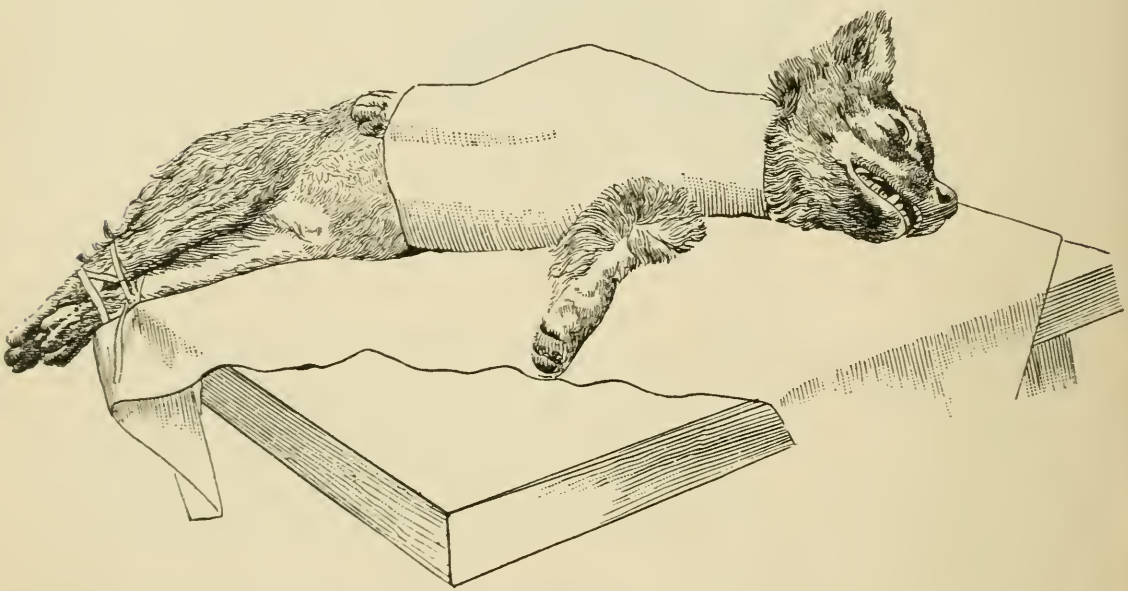


Fig. D.

This precaution will be found useful in other kinds of experiments, to prevent dogs from using their teeth upon dressing or apparatus.

Dog No. 2 was killed at the end of three and one-half months. Every joint presented a perfectly normal appear-

ance. Where the head of the humerus rested against the glenoid cavity, there appeared to be a little deeper bluish hue of the articular cartilage.

There was more atrophy of muscles than in dog No. 1, as compared with the opposite limb.

Dogs No. 3 and 4 developed mange, and were killed at the end of the 5th month, lacking one week (145 days). The joints were all normal, as in specimen No. 2. A section of the bones was made. Their structure presented no abnormality.

See Figs. E and F, from one of the dogs; 7 and 10, glenoid fossa; 8 and 9, head of humerus. In all of the

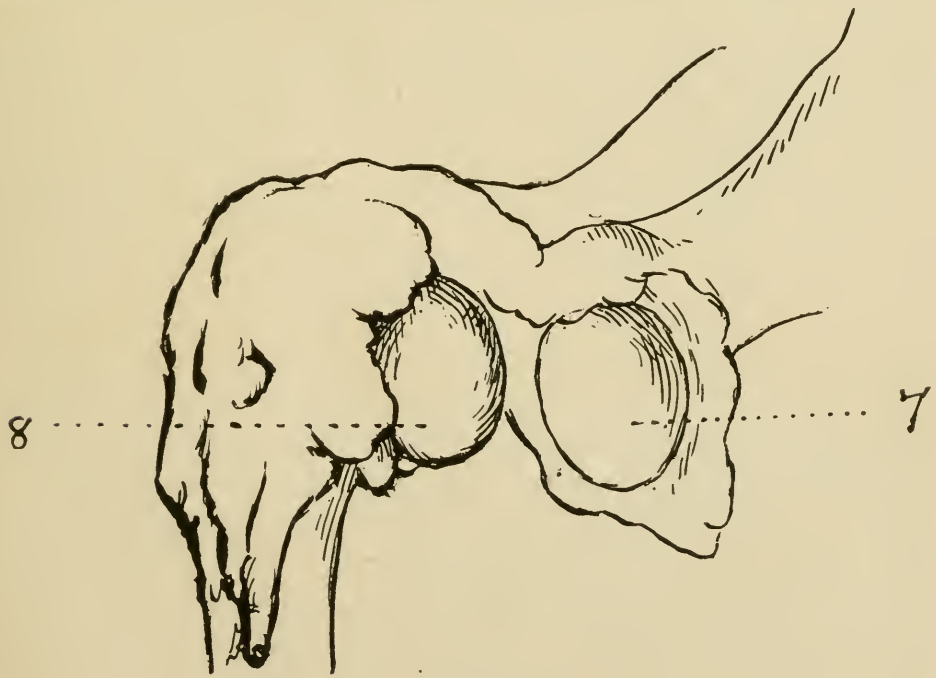


Fig. E.

joints the normal amount of synovial fluid was present, and of proper consistence. This was evident by comparing it with that of the joints which had not been immobilized, as the dogs were allowed to run about on three legs. The muscles were very much atrophied. After the removal of dressings, free motion of the joint was apparent,

it being restricted only by the contracted muscles. The contraction was easily overcome by stretching, when motion was as perfect as in the opposite limb.

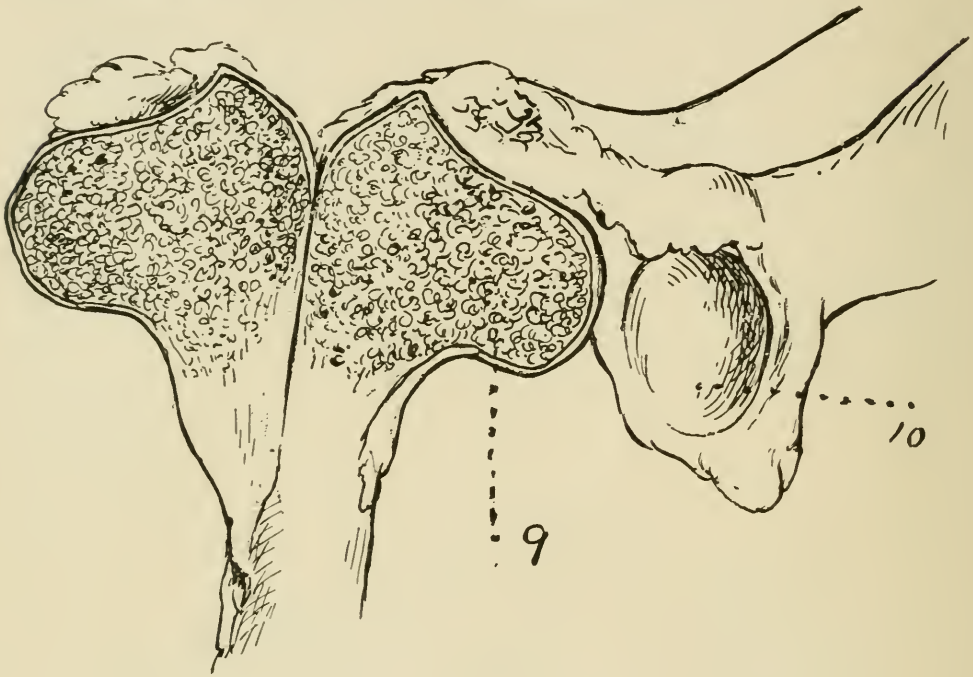


Fig. F.

Before beginning prolonged experiments upon animals, and especially dogs, they should be clipped, and thoroughly scrubbed in a warm bath with soap and a brush. Then immersed in a solution of bichloride of mercury 1–200 for a short time, finally the mercurial solution should be washed away with plenty of warm water. This process will not only remove filth, but will kill any vermin which, if left in the hair, would prove a source of annoyance to the animal, and might defeat the object of the experiment. Bitches about two years old are preferable to dogs, as they are more easily kept clean; they are not so likely to wet the dressings, as are dogs. They should be kept separate from all other animals, and their apartments kept well lighted and ventilated. The bedding should receive careful attention, and frequent changing.

Conclusions.

The conclusions at which we arrive from these experiments are :

1st. That a normal joint will not become anchylosed, by simply immobilizing it for five months.

2d. That motion is not necessary to preserve the normal histological character of a joint.

3d. That when a healthy joint becomes anchylosed, or its normal histological character changed, it is not due to prolonged rest, but to pathological causes.

4th. That immobolizing a joint in such a manner as to produce and continue intra-articular pressure, will result in destruction of the head of the bone and the socket, against which it presses, as is evidenced by Specimen No. 1, Figs. B and C, in which there was present the beginning of destructive changes.

5th. That atrophy of the muscles of the limb will follow prolonged immobilization of a joint.

Query.

In the treatment of wounds, inflamed organs and tissues, rest is one of the most important surgical laws. The surgeon protects the wound from friction by means of proper dressings, and the opthalmologist puts the inflamed iris at rest by the use of atropia and the dark room.

If these experiments prove that prolonged fixation will not produce anchylosis of a normal joint, that motion is not essential for the preservation of its normal function, *and since rest is a surgical law in the treatment of inflamed tissues in other parts of the body*, why should many orthopædists still persist in treating inflamed joints by motion ?

If motion in the treatment of joint disease prevents anchylosis, why is it that the statistics of joints so treated show that anchylosis and deformity, to a greater or less extent, are by far the most frequent result ?

It is because the severity of the inflammation, the tissues

involved, and the amount of destruction of bone, determine the question of anchylosis. Motion of an inflamed joint only interferes with repair, and more certainly hastens the case on to anchylosis and deformity. To prevent this calamity, absolute rest and the relief of intra-articular pressure should be the plan of treatment.

Inflamed joints treated upon the plan of absolute immobilization, and the relief of intra-articular pressure, furnish by far the best results.

The statistics from the Chambers Street Hospital of fifty consecutive cases of fracture at the elbow joint, published by Dr. Chas. A. Powers, show only one case of anchylosis. This is a better series of results than has heretofore been published. These cases were dressed with plaster of Paris, and kept perfectly at rest for weeks, and no passive motion was allowed. This plan allowed the normal process of repair to take place, without interruption. Motion could only have resulted in breaking up the new tissue formation, and endangering the future usefulness of the joints either by bony anchylosis, or cicatricial contraction of the soft parts.

TUBERCLE BACILLI FOUND IN THE BRONCHIAL GLANDS OF NON-TUBERCULAR SUBJECTS.

Results of the examination of the bronchial glands of fifteen persons who died suddenly, either from accident or acute disease, in whom no tubercular lesions were found at the autopsy. Demonstrated by the inoculation of the gland substance into animals.

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On the 4th of March of this year, I made an autopsy on a young wonan, 26 years of age, who had been in perfect health until four weeks before her death, when she was seized with fever and chills, which led to the diagnosis of malarial fever; one week later, the diagnosis of general pulmonary terberculosis was made. At the autopsy, both lungs were found studded throughout their entire substance with small gray miliary tubercules; no old tubercular foci were found in the lungs, nor any other evidence of disease, except tuberculosis. No point of infection could be found, except one large bronchial gland, which presented the characteristic changes of an old tubercular process. At a meeting of the N. Y. Pathological Society on February 27th, Dr. Van Gieson presented an enlarged bronchial gland removed from a patient who had died of phosphorous poisoning. Sections of the gland showed it to be tubercular. No tubercles were found in any other part of the body. These two cases suggested that possibly tubercle bacilli when enhaled pass directly to the bronchial glands, and there remain quiescent for a period, and afterward enter the lymphatic circulation or the blood current, and excite a local or general tuberculosis.

The general infection of the young woman referred to,

might thus be explained, if it can be demonstrated that tubercular bacilli are present in the bronchial glands of healthy persons, and it might remove the obscurity in the etiology of many cases.

It was with the hope of obtaining some facts which might throw light upon this question, that a series of autopsies were undertaken on persons who had died suddenly, either from accident or from acute non-tubercular disease.*

In all such cases a careful examination was made of each organ, especially the lungs, for evidences of old tubercular processes; if none were found, then the bronchial glands were removed, and placed in melted paraffine so that the hot paraffine would destroy all putrefactive bacteria that might contaminate the surface of the glands, and would render them sterile until an animal could be inoculated with their substance.

Within half an hour after removal, the glands were taken from the hardened paraffine, and reduced to a pulp in a sterilized crucible, to which a small amount of distilled water was added to render the fluid, obtained from the glands, thin enough to pass through the needle of a sterilized Koch syringe. About two cc. of the fluid, which had been obtained from the pulverized bronchial glands, were then injected into the right pleural cavity of a healthy rabbit. The rabbit was kept under the best hygienic surroundings, and if it did not die before the end of six weeks, was killed by being bled to death. A careful record was kept of the autopsy of the rabbit, and of the microscopical examination of the organs. If the first rabbit at the autopsy showed evidence of tuberculosis, a second rabbit was inoculated, under antiseptic precautions, with material obtained from the first, to determine positively the character of the lesions found in the rabbits, which were inoculated with the bronchial gland substance. Eleven rabbits died within twelve

* My position as Curator of Bellevue Hospital, and the courtesy of the City Coroners, enabled me to obtain autopsies on this class of cases.

hours to six days, either from a faulty inoculation, too large a quantity of fluid being used, the animal being injured by the needle of the syringe, or possibly because the glands had undergone decomposition, the autopsy on the body from which they were removed having been made too late. From these cases no conclusions could be reached, and they are not included in the list of experiments.

The question might arise, in determining the presence of the tubercle bacilli in the bronchial gland, instead of inoculating animals with the material of the glands, why not cut sections of these glands, and stain them for the tubercle bacilli? The reasons to my mind are two, viz.: In the first place, the bacilli in the glands may be so few and scattered, that it might necessitate a hundred sections being made to obtain under the microscope, that portion of the gland containing the bacilli; and secondly, in the appreciation of a small number of bacilli, a personal factor comes in; one observer affirming their presence, while to another, they are obscure. In answer to the objection that the material may have become contaminated before its inoculation into the animal, it may be stated that all the steps of the operation were conducted under the strictest antiseptic precautions, even to the removal of the glands from the dead body by sterilized instruments.

Six out of the fifteen persons in whom autopsies were made, had in their bronchial glands active tubercle bacilli. None of the persons presented any evidence of old or recent tubercular processes, yet the bacilli were within the bronchial glands, ready to enter the general lymphatic system of the lungs and set up a localized pulmonary tuberculosis, or by entering the general lymph or blood current, give rise to a general tuberculosis.

I have been unable to find the records of any systematic examination for the tubercle bacilli in the bronchial glands of non-tubercular adults. The only literature found bearing on this subject is the following: the presence of tubercular bacilli in the lymphatic glands at the root of the lungs and

in the mediastium, was repeatedly demonstrated by Bollinger on the bodies of children who died of measles during the great epidemic of that disease in Munich, although prior to their illness the children had been in apparently perfect health, and without any evidence whatever of tuberculosis. It has been positively demonstrated, that in most cases of tuberculosis in children, the disease is preceded by a long existent but latent glandular tuberculosis. The following synopses of half a dozen cases presented during the last few years before the London and the New York Pathological Societies illustrate this. Although they were not all confined to children, in all of them a tuberculosis of the bronchial glands preceded the general tubercular outbreak.

Cases from the London Pathological Society.

I. Caseous tubercle of the bronchial gland invading the lung; tubercular meningitis; general tuberculosis. Vol. 29, p. 322.

II. Acute tuberculosis; tubercular pleurisy and pericarditis, following caseous enlargement of the bronchial or mesenteric glands, in a child eight months old. Vol. 26, p. 246.

III. Caseation of bronchial glands; tubercular tumors of brain; miliary tuberculosis of lungs and kidney. Vol. 29, p. 11.

IV. Caseation and enlargement of several bronchial glands; one produced tuberculosis of mucous membrane of adjacent bronchus ; severe pulmonary tuberculosis, in a child nine months old. Vol. 30, p. 254.

V. Suppurating (caseous) tubercular bronchial gland opening into œsophagus and bronchus; tubercular ulcers of stomach and intestines; miliary tuberculosis of all organs. Vol. 36, p. 104.

Cases from the New York Pathological Society.

VI. General tuberculosis, enlarged bronchial glands with ulceration into right bronchus. 1888, p. 146.

VII. General tubercular meningitis; cerebral thrombosis or softening, enlarged bronchial gland, with ulceration into right bronchus, æt. seven months. 1888, p. 147.

VIII. Phosphorus poisoning; single enlarged bronchial gland, section of which showed tubercle bacilli. 1889, p. 120.

In his work on Pulmonary Tuberculosis, Prof. H. von Ziemssen says: "Tuberculosis may exist, and perhaps has

existed, for years in a child apparently in full health, and is often learned of accidentally. A single swollen gland, extirpated from an otherwise blooming and healthy child, has been found to contain giant cells with bacilli. If this condition is found in children, it suggests its possible occurrence in adults." With the hope of throwing light on this point, the following experiments were undertaken.

Case I.—An intoxicated woman was taken during the night to a police station and locked up in the cell. On the following morning she was found lying on the floor unconscious. Before medical aid could be summoned, she died.

Autopsy, ten hours after death.—The body was well nourished, and apparently in the prime of life. The kidneys were cirrhotic. There was slight thickening along the base of the aortic valve. No tubercular process, either old or recent, was found in any portion of the body.

One large and four small normal looking bronchial glands were removed.

Inoculation Experiments and Results.—The glands were prepared in the ordinary way. Three cc. of the fluid were injected into the right pleural cavity of a healthy rabbit. Forty-five days afterwards the rabbit, much emaciated, was killed. Both lungs, liver, spleen, and kidneys were completely studded with small gray miliary tubercles. The mesenteric glands were similarly involved. Tubercle bacilli were found in a section cut from the liver and lung. A pure culture on potato was made from the rabbit.

The single enlarged bronchial gland, removed from this woman, which measured one-half inch by one inch, had all the appearance of an old tubercular process. As the rest of the glands appeared normal, it seems probable, that the infection of the rabbit came from this enlarged gland. This rabbit at the autopsy presented similar lesions to those found in rabbits inoculated with a pure culture of the tubercle bacilli.

Case II.—G. J., æt. 32, a prize-fighter, who had come from California to give exhibitions in New York, was seized upon his arrival here with a chill; developed lobar pneumonia, and died on the seventh day of the disease.

Autopsy, made thirty-six hours after death.—All the organs were found in a normal condition, with the exception of the lower lobe of the left lung, which presented the ordinary appearance of the second stage of lobar pneumonia. There were no pleuritic adhesions, nor any evidence in any organ of the body of an old tubercular process. Four bronchial glands were removed, one of them being fully three times the normal size.

Experimental Inoculation and Results.—Immediately after removal 2 cc. of the fluid obtained from the bronchial glands were injected into a healthy rabbit.

Seven and a half weeks later the rabbit was killed. At the time of the inoculation, the needle had pierced the diaphragm, and the injected material had entered the peritoneal cavity, and infected the glandular system of the phrenic centre, resulting in a localized tuberculosis. On opening the abdomen, a mass of three large greyish-white nodules, the largest measuring one inch and a half in diameter, was found on the anterior superior surface of the liver. On the under surface of the diaphragm, connected with these, were fifteen to twenty small cysts, filling the upper and right side of the abdominal cavity. In each cyst was a small cheesy mass. The large nodules were found, after careful dissection, to be enlarged glands of the phrenic centre, while the small ones were dilated mesenteric lymphatics. Eight, small, white, round nodules were imbedded in the right and left lobes of the liver. In these nodules tubercle bacilli were found by the Koch-Ehrlich method of staining. The rest of the organs were perfectly normal, with the single exception of the lower lobe of the right lung, which contained a small translucent nodule.

A second rabbit was inoculated, in the right pleural cavity, with two small nodules removed from the first rabbit. Ten weeks later this rabbit was killed, and in both lungs were found a few miliary nodules, which on microscopical examination proved to be tubercular. All the other organs were normal.

A man in perfect health, and of extraordinary strength and physical vigor, is suddenly seized with an acute disease, and dies on the seventh day, and is found to have had tubercle bacilli in his bronchial glands, the presence of which was demonstrated, not only in stained sections, but by the results of the inoculations of rabbits. It would seem that the amount of virus in the second rabbit was so small, that the animal readily overcame the infection.

Case III.—Mary F., æt 30, was perfectly well until her confinement. After delivery she developed symptoms of puerpural septicæmia, and died on the ninth day.

Autopsy, made four and a half hours after death.

All the organs were found in a normal condition, with the exception of the kidneys, which presented, under the microscope, moderate parenchymatous degeneration ; and the uterus, which was enlarged, and contained a sloughy endometrium, with portions of the placenta still attached. The spleen was enlarged, soft and pliable.

Four slightly enlarged bronchial glands were removed.

Inoculation Experiments and Results.—A healthy rabbit was inoculated, in the right pleural cavity, with a syringe full of the fluid, obtained from the crushed bronchial glands. The rabbit died at the end of five weeks.

The right pleural cavity was covered with a dense fibrinous exudation, which compressed the lung, in whose lower lobe a small patch of consolidation was noted. The left pleural cavity contained some serum and fibrin at its lower part; the lung was normal. There were evidences of fibrinous pericarditis. The liver was studded with a number of small, white, translucent nodules, with cheesy contents. Microscopical examination of these nodules failed to reveal tubercle bacilli.

Five cc. of the fluid obtained from five of these nodules, were injected into the pleural cavity of a healthy rabbit, which was killed at the end of nine weeks, and found to be in a perfectly normal condition.

While the nodules found in the liver of the rabbit, presented an appearance resembling tubercular nodules, the control experiment showed conclusively that they were non-tubercular.

Case IV.—John R., æt. 40, a street vender, while following his business, pushed a cart before him about the streets. As he sat on the curb-stone with his cart in front of him, on the afternoon of May 17th last, a truck was driven against the cart, the handle of which struck him in the chest. He fell over and died almost instantly.

Autopsy, twenty-four hours after death.—All the organs were normal. The man had died from fractures of the second, third and fourth ribs, the vena cava being ruptured by the ragged edge of one of the ribs, filling the pericardial and pleural cavities with blood.

Five bronchial glands of normal appearance were removed.

Inoculation Experiments and Results.—A healthy rabbit was inoculated on May 19th, the glands having been kept over-night in hardened paraffine. On July 18th, the rabbit was killed, and all its organs were found in a normal condition.

This case proved, firstly, that the bronchial glands contained no tubercle bacilli, and, secondly, that the glands remained perfectly sterile for twenty-four hours in the paraffine.

Case V.—J. E., æt. 30, was admitted to Bellevue Hospital on May 27th, in the eighth month of pregnancy. She had been in perfect health until two weeks previous. At the time of admission, she presented the symptoms of puerpural uræmia. Four days later, labor was induced, and a dead child delivered. On the following morning uræmic coma was complete, and she died in the evening.

Autopsy, made twenty-four hours after death.—All the organs were normal except the kidneys, which presented the characteristic changes of acute parenchymatous nephritis. No evidences of old or recent tubercular changes were found.

Inoculation Experiments and Results.—Three bronchial glands which had been removed were crushed, and diluted with distilled water. Two cc. of the solution were at once injected into the right pleural cavity of a healthy rabbit. After July 14th, the rabbit showed signs of failing health, and on July 24th, it was killed. The pleural cavities were normal. A cheesy bronchial gland, as large as a small cherry, filled the posterior mediastinum. An old tubercular infiltration, which seemed to antedate the enlarged gland, involved the apex of the right lung. A small circumscribed eruption of recent tubercles involved the upper portion of the left lung. The rest of both lungs was normal. In the liver, a few small miliary tubercles were seen on the surface, while the spleen, stomach, and intestines were completely studded with miliary tubercles.

The apparently normal bronchial glands of this young woman, who had been in perfect health until a short time before death, and living under good hygienic surroundings, furnished a solution which, when injected into a healthy rabbit, produced general tuberculosis. At the autopsy, this rabbit presented appearances similar to those which are found in rabbits inoculated with a pure culture of the tubercle bacilli, and in its turn furnished on sterilized potatoes an equally pure culture of the bacilli.

Case VI.—George W., æt. 38, who had been drinking heavily for three weeks, was found in an unconscious condition on the street, and taken to the alcoholic ward of Bellevue Hospital. He died in four hours.

Autopsy, made ten hours after death.—No lesion was found in any of his organs, with the exception of the brain, which presented the characteristic appearances of the "wet brain," and the pancreas which was twice the normal size, and, under the microscope, showed extensive areas of hemorrhagic necrosis. There were no evidences of any tubercular processes in any part of the body. Six small bronchial glands were removed.

Experimental Inoculation and Results.—A healthy rabbit was inoculated with 1½ cc. of the fluid obtained from the glands. At the end of six weeks the rabbit was killed, and every organ was found in a perfectly healthy condition. The macroscopic appearance of the pancreas resembled to some degree the appearance produced by tuberculosis, but a number of sections made from various portions of the organ, showed that the necrotic-looking areas were composed of degenerated fibrin and blood corpuscles, with some broken down pancreatic tissue. No microscopical resemblance to tubercle was found. This case was presented before the New York Pathological Society.

Case VII.—Fredk. W., æt. 35, of robust physique, who had been in the habit of going on periodical sprees for the past six years, was brought into

Bellevue Hospital with the symptoms of acute alcoholism, and died twenty hours after admission.

Autopsy, ten hours after death.—The kidneys presented the lesions of chronic interstitial nephritis; the left heart was hypertrophied; the pericardial sac contained 8 oz. of clear serum, and the brain presented the ordinary appearance of the "wet brain" of alcoholism. The other organs were normal, and no old or recent tubercular lesions were found. Six bronchial glands were removed, one of which was greatly enlarged.

Inoculation Experiments and Results.—A healthy rabbit was inoculated in the right pleural cavity, with 3 cc. of the fluid obtained from the glands, and was then turned loose in the yard. Eight weeks later the rabbit was killed, and the right lung showed the characteristic lesions of diffuse tubercular infiltration, most marked in the lower lobe. The left lung was less extensively, but similarly, involved. In many places in both lungs, the tubercular infiltrations had undergone cheesy changes. On the parietal pleura were seen a few typical tubercles. The other organs presented a normal appearance.

The lesions found in the inoculated rabbit were so characteristic of tuberculosis that a control inoculation seemed unnecessary, and it was not performed.

Case VIII.—J. D., æt. 60, was in perfect health until six days before his death, when he suddenly became unconscious, and presented the usual symptoms of cerebral apoplexy.

Autopsy, made twenty hours after death.—All the organs were found normal, except the heart and brain. The heart showed slight atheroma of the aortic valves, with moderate dilation of the left ventricle. The brain contained in its left hemisphere a recent blood-clot, which involved the second and third frontal convolutions. No evidence of tuberculosis was found in any part of the body.

Inoculation Experiments and Results.—A healthy rabbit was inoculated in its peritoneal cavity with 4 cc. of the fluid obtained from six bronchial glands. Six weeks afterwards the rabbit died, and a localized chronic peritonitis was found, limited to the upper portion of the abdominal cavity. There were cheesy masses containing pus, over the liver and stomach, which presented all the microscopical appearances of tubercular abscesses, but repeated examination of these masses failed to reveal the presence of any tubercle bacilli. The abdominal glands were enormously enlarged; with this exception, the rabbit presented a normal appearance. A second rabbit inoculated, died at the end of six days from septic infection.

There is no evidence that the bronchial glands removed from this case contained tubercle bacilli; the animal inoculated evidently died of non-tubercular peritonitis.

Case IX.—George E., æt. 38, stevedore, while engaged in unloading a vessel, was instantly killed by the falling of a beam.

Autopsy, made twenty hours after death.—All the organs were found in a normal conditions, with the exception of extensive adhesions over the upper lobe of the left lung. A careful examination failed to reveal any old or recent tubercular processes. Death was due to an extensive depressed fracture of the skull, beneath which was a large hæmatoma. There was also fracture of three of the ribs. Six normal-looking bronchial glands were removed.

Inoculation Experiments and Results.—A healthy rabbit was inoculated in the right pleural cavity, with 5 cc. of the fluid obtained from the glands. Eight weeks later the rabbit was killed, and with the exception of adhesions and pigment deposits (from the injected fluid), over the lower lobes of the right lung, all the organs were in a normal condition. In this case the large amount of fluid injected seemed to have excited an adhesive pleurisy. The fluid was absorbed, but the pigment derived from the bronchial glands, in this, as in many of the other cases, remained at the bottom of the pleural sac, or was distributed along the lymphatic vessels of the pleura in delicate black lines. The lungs presented no evidence of tuberculosis.

Case X.—D. M., æt. 66, who had suffered over a year with cardiac symptoms, died suddenly.

Autopsy, made eighteen hours after death.—Extensive disease of the aortic and mitral valves was found, with dilatation and hypertrophy of the left ventricle. The liver and kidneys were small and cirrhotic. With the exception of intense congestion and œdema of the lower lobes, the lungs were perfectly normal. Six bronchial glands were removed, one of which was very large, pigmented, and fibrinous looking.

Experimental Inoculation and Results.—4 cc. of the fluid obtained from the glands were injected into the right pleural cavity of a healthy rabbit. At the end of six weeks the rabbit, which had become very much emaciated, was killed. The left lung was normal, but the right was completely consolidated, and bound to the chest wall. Single and collected nodules projected from the surface and studded the pulmonary tissue. Three small cavities were noted at the base. A nodule as large as an olive, containing grumous material and creamy-looking pus, completely filled the right lobe of the liver. Two nodules, the size of millet seeds, were found in the right kidney. The mesenteric glands were enlarged and pigmented. A second rabbit was inoculated in the right pleural cavity, with material obtained from the first, and died at the end of seven weeks, with the characteristic lesions of miliary tuberculosis.

Case XI.—James D., æt. 46, of strong, vigorous physique, was admitted to the Hospital with the symptoms of lobar pneumonia, and died on the fourth day of the disease.

Autopsy, made twelve hours after death.—The kidneys showed the lesions of a moderate amount of interstitial nephritis. The liver was fatty and cirrhotic. The lower lobe of the right lung was in the third stage of pleuro-pneumonia. The other organs were normal, and no evidence of old or recent

tubercular lesions could be found. Six bronchial glands were removed. One was enlarged, and contained a calcareous mass.

Inoculation Experiments and Results.—The glands were prepared in the usual way immediately after removal, and 4 cc. of the fluid obtained were injected into the right pleural cavity of a healthy rabbit. Six weeks afterwards, the rabbit was killed, and with the exception of complete obliteration of the right pleural cavity by organized adhesions, and a collection of pigment in its lower portion, all the tissues were in a normal condition.

There is no evidence that in this case the bronchial glands contained tubercle bacilli, although one gland was very much enlarged and contained a calcareous mass, showing that it must have been at some time the seat of cheesy metamorphosis. These glands were not placed in paraffine in the usual way, yet no septic infection of the rabbit followed the inoculation, and the large amount of fluid injected (5 cc.) produced no other result than an acute adhesive pleurisy.

Case XII.—Fanny W., æt. 17, when in excellent health, was attacked with acute pericarditis and died on the sixth day.

Autopsy, made fourteen hours after death.—All the organs were perfectly normal, except the heart, which presented the usual characteristic lesions of acute sero-fibrinous pericarditis. A careful examination of the lungs and pericardium excluded the possibility of tubercular infection. Five normal-sized bronchial glands were removed.

Inoculation Experiments and Results.—Three cc. of the fluid obtained from the glands, were injected into the right pleural cavity of a healthy rabbit. Ten weeks afterwards, the rabbit was killed. All the organs were found normal, except the liver, which contained the cicatrix of an old abscess, and a few nodules of cheesy degeneration. The right pleural cavity contained a small amount of clear serum. One of the larger nodules from the liver was inoculated into the right pleural cavity of a healthy guinea pig. At the end of ten weeks the animal was killed, and its organs were found perfectly normal.

This case not only showed that no tubercle bacilli were demonstrated in the bronchial glands removed from the young woman, but that the pericarditis was non-tubercular.

Case XIII.—Robert H., æt. 20, was in perfect health, until attacked with typhoid fever. In the third week of the disease he died.

Autopsy, made eighteen hours after death.—Ulcers were found along the lower portion of the small, and the beginning of the large, intestines, but they did not have the characteristic appearance of typhoid ulcers. The spleen was enlarged and softened, and from its substance a pure culture of the typhoid bacillus was obtained in gelatine, proving definitely the character of the dis-

ease. The rest of the organs were normal, with the exception of a number of easily detached adhesions which bound the right lung to the chest wall.

Six small bronchial glands were removed, also four inguinal glands.

Inoculation Experiments and Results.—Immediately after removal, the bronchial and inguinal glands were reduced to pulp in separate crucibles, and four cc. of the fluid obtained from each, were injected respectively into the right pleural cavities of two healthy rabbits. Six weeks later the rabbits were killed, and the organs in both were found normal. In this case, the inguinal glands were removed together with the bronchial, in the hope of ascertaining whether, if the latter should prove to be tubercular, the inguinal would be similarly infected. A second series of experiments are now being conducted, with the object of ascertaining whether in cases where the bronchial glands contain no tubercle bacilli, they may be lodged in other glands of the body.

Case XIV.—A. D., æt. 34, farmer, was admitted to Bellevue Hospital June 22d, after an illness of sixteen days. The diagnosis of trichina poisoning was made. The patient died on the fourth day after admission.

Autopsy, made four hours after death.—The tissues were found normal, with the exception of some of the voluntary muscles and the intestines. Microscopical examination of the muscles showed encysted trichinæ. No tubercular process was found on any part of the body.

Eight bronchial glands of normal appearance were removed.

Inoculation Experiments and Results.—The glands remained in paraffine for twenty-four hours, when a healthy rabbit was inoculated with three cc. of the fluid obtained. Nine weeks later the rabbit was killed, and all its organs were found normal.

Case XV.—F. F., æt. 45, was found dead by the police on the side-walk of one of the down-town streets.

Autopsy, made fourteen hours after death.—The kidneys were typical examples of the "small cirrhotic kidney." The left heart was hypertrophied and showed no valvular lesion. The lungs were normal, and no evidence of any old or recent tubercular process was found in the body. The brain was not examined.

Experimental Inoculation and Results.—The four bronchial glands removed were slightly enlarged, and very much pigmented. Three cc. of the fluid obtained were injected into the right pleural cavity of a healthy rabbit. Eight weeks later the rabbit, which had become much emaciated, was killed. Free pigment was found in the left pleural cavity, and over the surface of the lungs. Both lungs were firmly bound to the chest walls by old adhesions, and in places, fresh hemorrhages had occurred. A nodule the size of a pea was imbedded in the lower lobe of the left lung; about this was an extensive area of consolidation. The remainder of the lungs and the other organs were normal, with the exception of the liver, which contained six nodules varying in size from a pin-head to a small cherry, with also a number of collections having the appearance of grains of sand. Microscopical examination of one of the larger nodules failed to reveal any tubercle bacilli.

The five larger nodules were reduced to pulp, the fluid was diluted, and three cc. were injected into the right pleural cavity of a healthy rabbit. At the end of seven weeks the rabbit was killed, and the right lung was found studded, especially in the lower lobe, with miliary tubercles. A number were also found in the liver and spleen, but none in the left lung.

The result of the inoculation of the second rabbit proved the impossibility of a positive diagnosis of the lesions in the first rabbit, by microscopical examination alone. The processes in this second rabbit were plainly tubercular, and the gland removed from the man proved to contain the tubercle bacilli.

General Review of Cases.

The period of experimentation extended over nine months. During this time the substance from the bronchial glands removed from twenty-six persons was injected into healthy rabbits, which were kept under the best hygienic conditions. The majority of these twenty-six persons died suddenly, and none of them after a prolonged illness. A careful examination of all the organs in such persons failed to reveal any old or recent tubercular process. Eleven of the twenty-six experimental inoculations were failures, for the rabbits died before any tubercular infection, if present, could have shown itself, consequently these have not been included in the fifteen from which my conclusions are drawn. The bronchial glands removed from six of the fifteen cases, or forty per cent., contained tubercle bacilli, as demonstrated by the development of tuberculosis in rabbits inoculated with the substance of the bronchial glands. In three of the six cases, death occurred suddenly from accident, while they were in apparent health, and none of the fifteen, with one exception, were sick more than ten days. Two of the nine negative cases caused lesions in the inoculated rabbits, which resembled so closely tubercular nodules, that the inoculation of a second rabbit was necessary to determine their non-tubercular character. The

results of the inoculation of the gland substance in Case II. illustrates in a striking manner the possible presence of tubercle bacilli in the bronchial glands in persons of strong and vigorous physique, and in the fullest physical activities of adult life. Cases I. and V. furnished, in the fluid obtained from their bronchial glands, enough tubercle bacilli to set up in the rabbits inoculated, a general miliary tuberculosis, from which pure cultures of the tubercle bacilli were made on sterilized potatoes.

Cases VII. and X. both produced in the rabbits inoculated, a profuse pulmonary tuberculosis.

While the gland substance in Case XV. contained tubercle bacilli, the lesions found in the first rabbit, could only be rendered positive by the inoculation of a second rabbit. In almost all the cases inoculated, the pigment contained in the glands was seen in the rabbits at the point of injection, and it spread out along the lymphatic channels, which were beautifully mapped out by it.

There is one point we must not lose sight of, in the analysis of these cases: they were principally taken from the lower walks of life, most of them hospital cases. Such persons must necessarily be surrounded by impure air and are more exposed to the possible inhalation of tubercular bacilli in large numbers than are those who, in large and well-ventilated apartments, live under better hygienic surroundings.

May not the facts obtained by these experiments furnish an explanation of the development of pulmonary tuberculosis in persons with no hereditary phthisical tendencies, who, at the time of its development, are under the best hygienic conditions, in whom the tuberculosis seemed to be excited by an acute simple bronchial catarrh or by some other acute non-tubercular pulmonary disease?

It has been demonstrated that tubercular bacilli may be inhaled in respired air. The position of the bronchial glands, and the arrangement of the lymphatics in the respiratory tracts, render it easier for the inhaled tubercular

bacilli to enter them than the lung parenchyma, for it is to be remembered, that just beneath the mucous membrane of the lower portion of the trachea and the mucous surface of all the bronchi, is an immense network of lymphatic vessels, running directly into the bronchial glands, which are situated between the right and left bronchi, and along the first divisions of the bronchial tubes, as they pass into the lungs. On the mucous surface of the trachea and larger bronchi, the tubercle bacilli would be more liable to lodge, than to be carried down to the pulmonary alveoli. If the integrity of these mucous surfaces is weakened, as occurs during mild attacks of bronchial catarrh, the direct passage of the tubercle bacilli into the bronchial glands would be favored. As is indicated by the cases reported above, the tubercle bacilli may remain quiescent in this situation for an indefinite period, but still retain all their virulence, as is shown in the experiment in case No. V.

While these experiments establish the fact that tubercle bacilli gain entrance into the bronchial glands of perfectly healthy persons, and apparently remain quiescent in them for an indefinite period, further experimentation is necessary to determine if other glands such as the axillary, inguinal, etc., of healthy persons, may not also be the resting place of bacilli, from which they may at any time, when the vital power of the blood is lowered, pass into the general or lymphatic circulation and cause local or general tuberculosis.

A REFLECTION GALVANOMETER.

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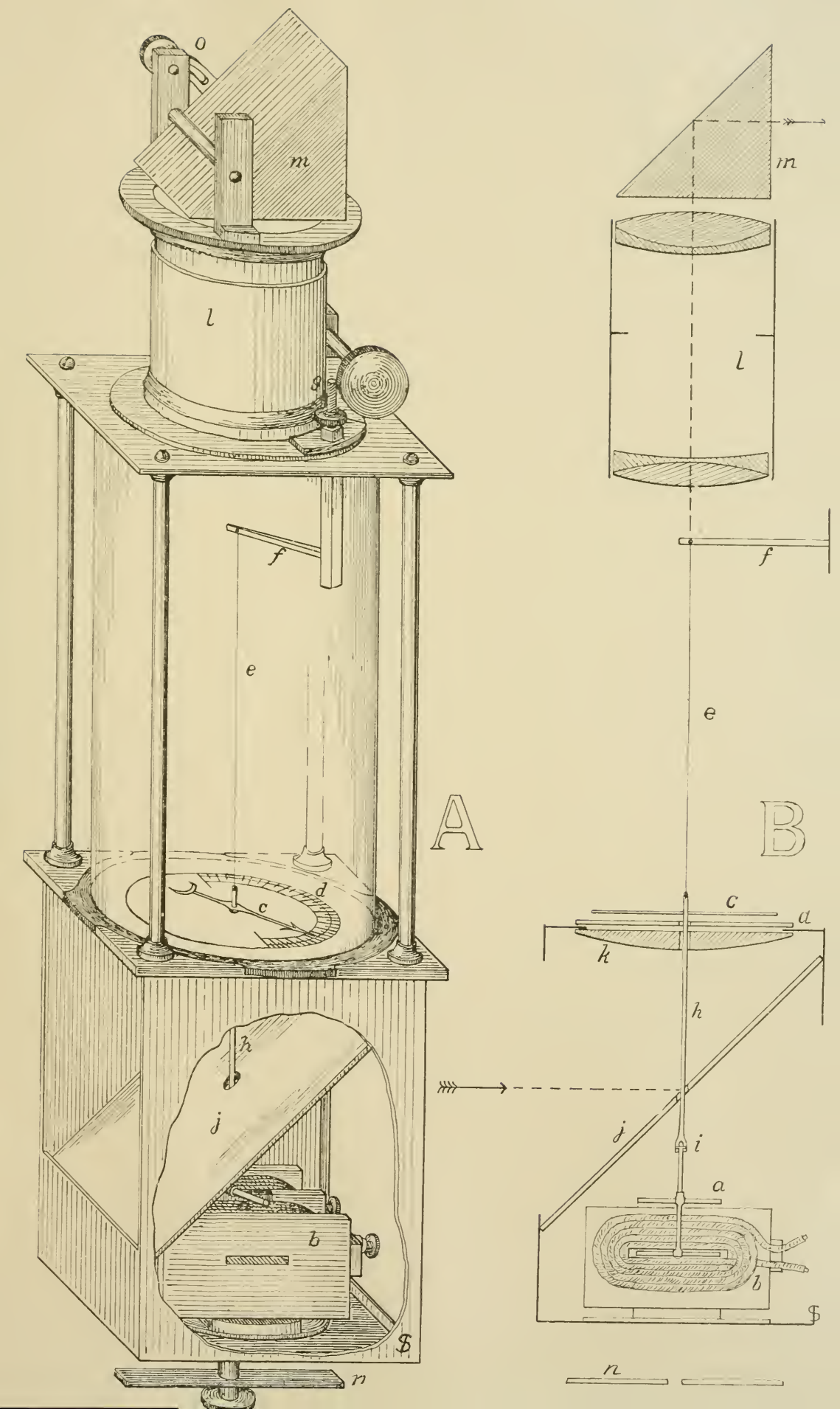
Lecturer on Chemistry and Physics.

The difficulty of exhibiting to a class the movements of the needle of an ordinary galvanometer, led to the design and construction (in the workshop of the Department of Chemistry and Physics), of the instrument figured in the accompanying engravings:

Figure A shows the galvanometer one-third its full size. Fig. B, is a diagramatic section. It consists of two portions —electrical and optical. The electrical has an astatic needle *a*, which may be influenced by a current passing through the coil *b*. The needle is attached at *i* to an aluminium wire *h* carrying an index *c* of the same metal, and suspended by a single silk filament *e* from an adjustable bar *f*. The needle is thrown out of action by lowering the screw *g*, and may be removed by detaching it at *i*. The index *c* is held in place by friction, and may be adjusted to any desired direction. The optical portion consists of a silvered glass mirror *j*, placed at 45°. It receives the light (made nearly parallel) from the condenser of the lantern, and reflects it upwards through the instrument. A hole, large enough to allow the aluminium wire to turn freely, is bored in the middle of the mirror. From the mirror the light passes through a plano-convex lens *k*, three and one-quarter inches in diameter, and ten inches in focal length. This lens supplies the place of the outer element of the lantern condenser, which is removed. Above the lens is a circular piece of thin glass *d*, with a scale photographed on it, as shown in the engraving, and supported by a ring of brass, which is capable of rotation. Both scale and lens are perforated for the aluminium wire. Above the suspending arm of the silk filament is an ordinary photographic lens *l*,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used as a projector, and mounted on the top of the lens is a right-angled prism of glass *m*, for directing the light on the screen. This prism is so arranged that it may be rotated in the axis of the instrument, or turned until its longest side is parallel to the axis, in which position it inverts the image on the screen. It is secured in either position by the pinch-screw *o*.

For some experiments the bar-magnet *n* is attached below the coil to control the position of the astatic needle.

The lantern, to which the galvanometer is fastened when used, has levelling screws for vertical adjustment. The coil, scale, index and prism, are all capable of rotation in the vertical axis, thereby enabling the lantern to be placed in any desired position with reference to the meridian.

The needle responds quickly, and the galvanometer may be used for any of the many purposes for which it is designed. Several coils of different resistances have been made for it. These are easily exchanged by unhooking the needle at *i*, lifting out the coil with the needle, changing the needle to the new coil, which is then placed in position on the circular plate in the box.

EXPERIMENTS REGARDING THE TENACITY OF EXPERIMENTAL RABIC VIRUS.

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The conflicting statements of different experimenters regarding the tenacity of the rabic virus, and some irregularities in the period of incubation of the disease, that I had the opportunity of observing while experimenting on rabbits with a virulent cord sent to me from Europe last year, induced me to establish a series of experiments in order to ascertain the changes of intensity that the virus undergoes, when submitted to different temperatures, to the action of time, or to putrefaction.

It is a well-known fact, that if virulent cords are allowed to dry, their virulence decreases proportionately with the time they remain in an atmosphere deprived of aqueous vapor, and this is the basis of Pasteur's anti-rabic inoculations; but whether the virulent cords can be indefinitely kept (in an aseptic condition), or whether moderately high temperatures or putrefaction interfere to such an extent as to destroy entirely their virulence, is what I propose to demonstrate.

Pasteur, Roux and Thullier assert as a consequence of their experiments, that putrefaction or high temperature completely destroys the virulence of rabic virus, while Galtier has proved that even sixteen days after the death of a dog, its cord was virulent as ascertained by successful inoculations in rabbits, notwithstanding the advanced stage of putrefaction of the dead animal. Novi of Bologna published the results of some experiments regarding the influence of putrefaction on the virulence of rabies, and he too, has arrived at Galtier's conclusions.

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* The first series of experiments were made in the Carnegie Laboratory. The second at the Loomis Laboratory.

My experiments extend over a period of eighteen months, and have been chiefly directed to studying the influence of time and putrefaction on the virulence of the cords extracted from rabbits that died within the usual period of time, after being inoculated by Pasteur's sub-dural method with an emulsion of *virus fixe*.

The initial virus, with which I began the series of inoculations, was sent to me from Naples by Dr. Marotta, assistant of the First Medical Clinic in the University of that city. The method of sending the cords, was suggested by me to Dr. Marotta, as an experiment only, for I am not aware that any one has tried it before. It is quite simple and effective, and avoids the necessity of sending an intelligent person to Paris, or some other institute where the virus is constantly kept, and taking inoculated animals through long voyages.

The virulent cords after having been extracted in the ordinary way from the dead rabbit, are dropped into a sterilized test tube, in the bottom of which a piece of sponge, or of cotton, soaked in a mixture of glycerine and water, has been previously placed. The tube is then sealed with a Bunsen lamp, and sent to its destination. The cords, if properly handled, keep aseptic for an indefinite length of time. The sponge or cotton, soaked in the mixture, maintains a damp atmosphere in the sealed tube, which is absolutely necessary to insure success. The engraving is an exact reproduction of a sealed tube containing such a cord.

Four tubes were sent to me at different periods, and all arrived safely, and with the virus exhibiting ordinary virulence, *i. e.*, producing death by rabies when inoculated after an incubation of eight or nine days, though some differences were observed. These were due, as I afterwards ascertained, to the temperature, as some of the cords came over during the summer of 1888, and others during January, 1889.

I hope that this method of obtaining virulent cords will prove as useful to others, as it has been to me.

To facilitate description I will divide the subject into three parts.

First.—The influence of age on the virulence of rabic cords.

C. sealed tube containing A. A. cotton soaked in glycerine and water. B. spinal cord of rabbit.

Second.—The influence of temperature on the virulence of rabic cords.

Third.—The influence of putrefaction on the virulence of rabic cords.

INFLUENCE OF AGE ON VIRULENCE.

The first cords (two tubes), I received on the 16th of July, 1888. They were mailed in Naples on the 23d of June, 1888, and belonged to a rabbit of the 23d series, that died ten days after having been inoculated sub-durally. The cords were apparently in good condition, presenting no signs of contamination.

With one of these cords I inoculated, on July 20th, 1888, two strong, healthy rabbits sub-durally. After a lapse of seven days, the animals began to present the classic symptoms of laboratory rabies, and died before the tenth day after inoculation had elapsed (July 30th, 1888). Their cords were extracted, and one was used to inoculate two more rabbits, while the other cord was kept in a sealed tube. To my surprise, twelve days passed without the animals presenting any symptoms. The thirteenth day, paralysis began to manifest itself in one rabbit, and the next day, in the other. Both died between the fifteenth and sixteenth day after inoculation (August 16th). Their cords were excised ; one was sealed, and the other inoculated in a third series of rabbits. In those animals the incubation was longer, and more irregular. One died after sixteen or seventeen days, and the other after twenty-one days. Not knowing the cause of this, I ceased inoculating, as my object was to obtain a steady virus (*virus fixe*) for other purposes. I sealed one of the cords of this third series, and requested Dr. Marotta to send me some more virus.

By an accident, the second tube of the original virus which I had kept was broken, and my first efforts to obtain a normal series of rabic rabbits came to an end.

The cords which I had sealed (July 30th, Aug. 16th and Sept. 2d), were in such a good condition that I thought of trying them again. I inoculated three rabbits from one of each of the cords on the 16th of October, 1888, and after seven days, to my surprise, all of them were affected with symptoms of incipient paralysis of the hind legs. Two died between the tenth and eleventh day, and the third on the eleventh day after inoculation (Oct. 27th).

From these animals I inoculated three more, two of which died after ten days, while the third lived six months, after which time it was re-inoculated with new virus, and died.

Here was a series of experiments of some importance. Rabies had been produced with cords of different ages. Two rabbits died after ten days, inoculated with the original virus from Italy twenty-seven days old. Two rabbits inoculated respectively with cords of 118 days, (cord of July 20th, inoculated Oct. 16th), and sixty-one days (cord of Aug. 16th, inoculated Oct. 16th), died after regular incubation, and a third rabbit that lived for over six months, died after inoculation with a cord seventy-eight days old (July 30th, to Oct. 16th). Another fact was, that some cause had altered the period of incubation of the disease ; during the first experiments it increased, while it returned to almost normal in the experiments of October.

The 26th of January, 1889, I received two new tubes containing the spinal cords of a rabbit that died in Naples the 3d of January, 1889, nine days after inoculation; it belonged to the 25th series. On January 30th I inoculated three healthy rabbits; one died on the 6th of February, after seven days, the other two on the 8th. The symptoms in all were perfectly characteristic. I extracted the cords, and kept them in sealed tubes. A successive series of inoculations, continued until the temperature of the atmosphere began to rise, proved them to have an average term of incubation of seven and a half days. On March 5th, 1889, two rabbits were inoculated with the original virus, sent to me by

Dr. Marotta; this virus was sixty-one days old (Jan. 3d to March 5th), and it produced death in eight to nine days after inoculation. May 20th, another rabbit was inoculated with virus 137 days old (Jan. 3d to May 20th), and it died on May 29th.

The rabbits inoculated, during the hot summer months, with old virus, presented, without exception, irregularities in the time that elapsed from the inoculation to the death of the animals. Of those irregularities I will treat under the heading of the influence of temperature.

My last experiments regarding the age of the virus were made during the past September and October. On the 23d of September, two rabbits were inoculated with cords extracted on the 8th of February, 166 days old, and both animals are still living. October 15th, two more rabbits were inoculated (cord extracted Feb. 22d, 174 days old); one died after nine days, the other about twelve hours later.

In all these experiments where rabbits were inoculated with old virus, a series of animals were tested in order to avoid errors, and in all, when the atmospheric temperature was not above 75° or 80° Fahr., the animals died within normal periods, *i. e.*, from seven to nine days from the time of inoculation to death.

INFLUENCE OF TEMPERATURE ON VIRULENCE.

The rabbits inoculated during summer do not die within the normal period of incubation (seven to nine days). As soon as the cold season approaches the virulence seems to regain its former intensity. Whether this is due to the influence of temperature alone, or to all the meteorological factors combined I am not yet able to state in an absolute proposition. It appears, however, as far as my experiments extend, that a high temperature is the principal, if not the only, factor in the problem. During last winter I kept inoculated rabbits exposed to cold weather, and in them the symptoms were much more severe than in other rabbits that were purposely kept in a very warm room. This has been observed in six consecutive experiments. Rabbits exposed to cold, died in from two to four and half days less time than those kept in a very warm atmosphere. The experiments in tubes have proved the same thing. These experiments were made during the cold season by exposing the cords to varying temperatures in a thermostat.

All the cords were kept for the same length of time, eight days, in an incubator. The temperatures were of 30, 35, 40, 45 and 50 degrees centigrade.

The rabbits inoculated with a cord exposed eight days to 30° c. died after a regular period of nine days. Those inoculated with cords exposed to 35° c. also died, though the period in one case was eleven, and in another twelve days. In other cases, 35° c. had a very marked tendency to lengthen the time. One rabbit died eighteen, and the other nearly twenty days, after inoculation. Those inoculated with 40° c. exposure, presented marked symptoms of hydrophobia, but did not die, and the last at 50° c. were not at all affected.

The four last rabbits, two inoculated with cords exposed for eight days to

a temperature of 40° c., and two with cords exposed for the same time to 50° c., had not acquired immunity, for a second inoculation, after some time, proved fatal to all.

These experiments in tubes prove nothing more than an attenuation of virus by temperature, and cannot, indeed, be very happily compared with what happens to the animal organization under the influence of a hot climate. They explain some things, but not all. Experimentation in the way of submitting the animal to conditions that resemble the atmospheric phenomena, after having been inoculated with cords with the *maximum* of virulence, is the only way of resolving the problem, and that I propose to do during the coming winter.

INFLUENCE OF PUTREFACTION ON VIRULENCE.

Putrefaction seems to affect but little, the virulence of rabic virus. Several experimenters have proved this beyond a doubt, and I will, therefore, refer to their experiments merely because I have somewhat changed the technique. Inoculation of putrid substances under the *dura mater* of an animal, is almost certain to produce death in a very short time. This is a great difficulty encountered when experimenting with rabies. Subcutaneous inoculations, with the emulsion of virulent cords, do not constantly and invariably produce death. The sub-dural or Pasteur's method, and the sub-perineural, or Di Vistea's method, are the only infallible ways of producing the experimental disease, but both are liable to the same objections in this particular case, viz.: the inflammatory processes caused by the inoculation of putrefactive and other bacteria constantly found in decomposing organic matter.

My experiments were made, first, with decomposing rabic cords exposed to the free air ; second, with cords decomposing in sterilized earth, and third, with cords extracted from decomposing animals.

The first were cords extracted in the usual manner, but without using aseptic precautions, and allowed to putrefy in open tubes. The first rabbit was inoculated with an emulsion of ten days' standing ; the animal died during the night after inoculation ; its brain was intensely congested and some cultures of staphilococcus aureus were obtained among many other varieties of bacteria. The second rabbit was inoculated with a twenty days' cord ; it grew sick, but recovered, and died after ten days, with symptoms of rabies; its cord was inoculated in another animal that died with rabies. The third rabbit was inoculated with a thirty days' decomposing cord and died of meningitis. Out of three rabbits inoculated with buried cord, two died with hydrophobia after the usual time, and the third one, twenty-four hours after inoculation. The last one belonged to a cord which was buried for ten days.

The last series of rabbits, three in number, were inoculated in the same manner, with the cord of the decomposing animal. In order to avoid as far as possible the odor of decomposing animal matter, only the spinal column and the cord within, were kept. All the rabbits died shortly after inoculation. This gives six failures in nine cases, or 66 per cent. Three of them, however,

were affected by the virus, and died with symptoms of hydrophobia in about the normal period of time. It is to be noted that none of the rabbits inoculated during the early stages of putrefaction, could be saved from sudden death.

To avoid the dessication of the cords, and consequently their attenuation during the process of putrefaction, they were constantly kept in a damp and warm atmosphere.

Conclusions.

From the preceding experiments the following conclusions are formulated:

1st. The virulence of rabic cords is not sensibly affected by old age, if they be kept aseptic, and in proper conditions of temperature and humidity.

2d. Moderately high temperatures acting in experiments in tubes, have an attenuating influence on virulent cords; atmospheric temperature influencing inoculated animals seems to affect the virulence, but further experimental data are needed before deriving any definite conclusion.

3d. Putrefaction does not relatively affect the virulence in a reasonable length of time.

This article was already written, when I received a letter from Dr. Acosta, Director of the Anti-rabic and Bacteriological Institute of Havana, Cuba, telling me about having observed the same irregularities in the course of experimental rabies, during the hot summer months. I am very glad that such observations have been made by others besides myself, for it proves that I have not been misled, when I attributed to climatic influences, the changes in virus intensity.

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